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QUARTERLY

OF THE

National Fire Protection Association

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87 MILK STREET, BOSTON, MASS.

EDITED BY THE SECRETARY

National Fire Protection Association.

Executive Office, 87 Milk Street, Boston, Mass.

Franklin H. Wentworth, Secretary

April, 1919

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American Institute of Consulting Engineers
American Institute of Electrical Engineers
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National Association of Insurance Agents.
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National Association of Manufacturers of United States.
National Association of Master Gravel and Slag Roofers of America.
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National Association of Sheet Metal Contractors of United States.
National Automatic Sprinkler Association.
National Board of Fire Underwriters.
National Convention of Insurance Commissioners
National Electric Light Association.
National Implement and Vehicle Association.
National Lumber Manufacturers' Association.
National Paint, Oil and Varnish Association.
National Wholesale Druggists' Association
National Wholesale Grocers' Association
Nebraska Inspection Bureau.
New Brunswick Board of Fire Underwriters
New England Bureau of United Inspection.
New England Insurance Exchange.
New Hampshire Board of Underwriters
New Jersey Schedule Rating Office.
New York Board of Fire Underwriters.
New York Fire Insurance Exchange.
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Nova Scotia Board of Fire Underwriters.
Ohio Inspection Bureau.
Ohio State Fire Prevention Association
Oklahoma Inspection Bureau.
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Underwriters' Association of New York State.
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Underwriters' Laboratories.
Underwriters' Service Association.
Vancouver Island Fire Underwriters' Association.
Water Works Manufacturers' Association.
Western Actuarial Bureau (Fire.)
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
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Courtesy Electrical Review.

FIG. 1. CENTRAL FIRE ALARM STATION, SAN FRANCISCO (see page 374).

"What facilities for extinguishing a fire have you in your village?" the inspector inquired. The inhabitant pondered for a minute or two. "There's the rain," he said.—*Whitlings.*

The Quarterly

Vol. 12 **April, 1919** **No. 4**

Twenty-third Annual Meeting. The holding of the twenty-third annual meeting of the Association (set for May 6th, 7th, and 8th) at Chateau Laurier, Ottawa, Canada, seems to have met with universal approval on the part of the membership. Canada has but ten per cent. of our associate members, but this ten per cent. has always been one hundred per cent. loyal, and it is a matter of keen satisfaction to them that the Association is to assemble in the Dominion Capitol at a time when the Canadian government is showing an exceptional interest in fire prevention.

The principal details of the meeting, hotel rates, etc., have been announced in the *News Letter,* and the official program will be mailed to members in advance of the meeting.

It has been the thought of the Program Committee that the full value of this meeting in Canada will lie in our members from the States getting acquainted with Canadian problems, conditions and methods and meeting on their own ground their fellow members in Canada. With this end in view the technical discussions will be principally confined to those incident to the consideration of the committee reports, only one special topic being scheduled for debate this year. It is a pity delegations to this meeting cannot be present from our membership in England, Australia, New Zealand and South Africa, to cement our modest portion of the English-speaking world in the great fellowship foreshadowed by the League of Nations.

* * * * *

The Pittsburgh Film Fire. The disaster in a Pittsburgh film exchange, concerning which a report by the National Board of Fire Underwriters (Member N. F. P. A.) appears on another page, forcibly illustrates the timeliness of the Association's efforts to safeguard the hazards presented by existing nitrocellulose film and to prepare the public for the prohibition of the use of any but slow-burning types. The cessation of the war, by increasing the supply of material needed for the manufacture of slow-burning film, will undoubtedly help the work of education in which the special Committee

on Motion Picture Films, under the chairmanship of Mr. A. R. Small, is engaged. Even under the most favorable conditions, however, some years must elapse before the hazardous type of film can be completely eliminated, and from this viewpoint the suggested regulations for safeguarding film storage which will be presented to the Annual Meeting next month by the Committee on Hazardous Chemicals and Explosives, Mr. George W. Booth, Chairman, are a contribution of the greatest importance.

* * * * *

Safe Building Construction. Serious concern is being manifested in several quarters on the subject of the chaotic conditions at present prevailing in relation to building operations. The Building Officials' Conference, at its fifth annual meeting held in Pittsburgh on February 6, 7 and 8, adopted resolutions favoring legislation to restrict building operations to persons properly qualified to prosecute such work safely and in accordance with the laws. On the other hand, recent issues of *The American Architect* have contained some outspoken criticisms of the methods—and, upon occasion, of the competence—of building departments. Particularly damaging disclosures with respect to the Boston Building Department, as it was in 1915, have been made in connection with the investigation of the molasses tank collapse reported elsewhere in this issue. It appears that the officer responsible for approving the plans was unable to compute the static pressure in such a tank, and that he assumed the adequacy of the design because the drawings bore the name of a civil engineer. An example of the way in which defects of drafting and "jokers" may work havoc with local measures is afforded by the housing bill which has been before the Illinois legislature during the past few weeks. According to *The American Contractor* (issue of March 22, 1919), the American Housing Association, which was in sympathy with the general purposes of the bill, was compelled to choose between opposition or drastic amendment. Careful study of the draft showed that among other defects the bill would annul the building ordinance of Chicago which forbids tenements more than three stories high except they be of fire-resistive construction. The removal of this restriction would permit tenements of quick-burning type to be erected to a height of 80 feet, or six or seven stories.

It has long been recognized by fire preventionists that trouble of this kind can be avoided only by standardization of certain features after thorough investigation by technical experts. The Building Code of the National Board of Fire Underwriters was produced under just the required conditions, and the general discontent with the existing state of affairs should be a valuable asset to the propaganda for the adoption of that code by all the larger cities.

* * * * *

Forest Fire Protection. The Minnesota forest conflagration of last fall seems to have quickened the interest of the authorities responsible for forest fire protection, not only in that State, but in many other places. Experiments with airplanes as

aids to the forest fire patrols are to be made during the coming year in the provinces of British Columbia and Quebec, and there is even talk of co-operation by the Dominion Government through the Canadian Air Force.

The subjoined note from the *American Lumberman* of March 1, 1919, is also of interest in this connection:

CHAPEL HILL, N. C., Feb. 24.—The North Carolina Geological and Economic Survey is urging that the State's vast forest wealth be given adequate protection by making effective the laws at present on the statute books. Approximately 19,000,000 acres, or about two-thirds the area of the State, is in forest, the products of which represent an annual income of $75,000,000, and yet the State spends only $1,300 on fire protection.

The need for better protection is shown by the fact that forest fires, 90 per cent. of which were caused by carelessness or negligence, represent an annual loss of more than $900,000. Although the forest fire law of 1915 provides a system for preventing a large proportion of these fires, which the United States forester says is "one of the best in the United States," it can not be put into effect because no appropriation has yet been made—this despite the fact that the Federal Government offers strong financial assistance if the State will spend as much money, or more.

Experience in Tyron Township, Polk County, is quoted as showing what results may be accomplished by an adequate appropriation. During three years and a half prior to the appointment of a patrolman 17,840 acres were burned over, causing damage estimated at $65,800. During a similar period since the patrol was started but 693 acres were burned over and the damage was only $2,600, the patrol resulting in a saving of $18,000 a year in this one township.

In support of its plea for an appropriation of $10,000 by the General Assembly, the following comparative figures are quoted to show what is being done by other States for the protection of forests:

	Acres of forest land	Amt. spent on fire protection
Maryland	2,200,000	$ 38,000
New Jersey	2,000,000	24,000
Maine	15,000,000	98,000
Minnesota	15,000,000	47,000
Massachusetts	2,000,000	31,000
New York	12,000,000	98,000
Kentucky	10,000,000	71,000
Pennsylvania	9,000,000	185,000
North Carolina	19,000,000	1,300

* * * * *

Fire Prevention Education in Fitchburg. Fitchburg's fire loss in 1917 was triple that of 1916. This caused Fire Chief Hyatt to feel that something must be done to educate the citizenry in fire prevention, and he accordingly planned an illustrated lecture on the subject. Two members of the department were set to work, and lantern slides were prepared showing serious local fires and hazardous conditions in home and factory. A writer in *The American City* says that a distinct interest in fire prevention has been created by this means, the lecture having been delivered in every school in the city and before a number of public gatherings.

Fire Safety of Army Hospital. A grim interest attaches to a Chicago controversy regarding the new government hospital at Fort Sheridan and a rival structure, the Speedway Hospital, erected by Edward Hines, president of the Edward Hines Lumber Company, largely as a memorial to his son, who died in France. Mr. Hines planned to sell his building to the government, but officials turned the proposition down after the buildings were nearly completed. The *Insurance Post* thus comments upon the situation:

> The interest of fire prevention experts is in the comparative fire-resistive qualities of the two propositions. The Hines hospital is of brick and hollow tile construction, with frequent fire-resistive cut-offs between the sections, and is constructed with reference to the special need for fire prevention and protection in buildings intended for hospital uses. The Fort Sheridan buildings, on the contrary, are of frame construction and are regarded as exceedingly hazardous for the housing of sick and crippled soldiers. . . . He (Mr. Hines) has been attacking the Fort Sheridan hospital through full-page advertisements in the Chicago newspapers and costly propaganda through the mails and numerous organizations. He bases his criticisms almost entirely upon the fact that it is of wooden construction, and he dilates at length upon the outrage of submitting the returning heroes of the army and navy to the hazards of frame buildings.

* * * * *

Sprinkler Inspection in Knoxville It is understood that the City Commissioners of Knoxville, Tenn., have provided for the inspection of mercantile and manufacturing properties with a view not only to the correction of hazardous conditions but also to the proper maintenance of sprinkler equipments. Branch Manager C. D. Beardsley of the Tennessee Inspection Bureau (Member N. F. P. A.) estimates that at least 80 per cent of the values coming within mercantile and manufacturing classifications in the city are under sprinkler protection, and it seems to be his opinion that the service planned by the Commissioners will prove of the utmost value.

* * * * *

School Drill Efficiency at Long Beach, Calif. On the morning of December 27th, 1918, a fire started in the furnace room of the American Avenue Grammar School, Long Beach, and flames were communicated to all parts of the building by a motor-driven fan which forced hot air currents through the pipes of the heating system. This condition prevailed before there was any realization that the building was on fire. Nevertheless upon the arrival of the fire department all of the teachers and pupils (more than 600 children ranging in age from "Kindergarteners" to eighth grade students) were out on the streets. Within two minutes after the fire alarm sounded the school had been emptied without loss of life or injury to a single person.

It was impossible to save the building, which was a two-story-with-loft building, 187 x 110 feet in area, wood construction, part brick veneer, with cement plaster over wood lath, with wood shingle roof.

Member H. Stanley Ellis, Engineer of the Bureau of Fire Prevention,

gives the following interesting details of the arrangements for fire drills which proved so valuable on this critical occasion:—

"The fire drill is maintained in all public schools of this city, also all private schools have been recommended to use the drill by both Fire Chief G. C. Craw and myself.

"The fire alarm signal is given by electric bells in various parts of the school buildings, and upon its sound, the students arise from their seats and file out in double line in charge of their teachers. They are not allowed to stop to take books, papers, wraps, or anything with them but the minute the bell sounds they begin to march in an organized manner; certain older male students are instructed as firemen and place themselves at certain stations in the building where hose racks and chemical fire extinguishers are, also at the top and bottom of each flight of stairs or fire escape. They always station themselves in groups of two. If the fire is at their station they go to work on it with the 1½-inch linen hose water line or chemical fire extinguisher; if there is no fire at their station they make sure that all persons are out of their part of the building, then they leave the building together and report to their respective teachers. Provision is made where certain children need special attention; student firemen in groups of two are detailed to conduct each child from the building; these student firemen do no other fire work.

"A very efficient fire brigade is maintained at the High School under a student fire chief, each member being furnished with a High School fire department badge. The members of this brigade are drilled in handling both 1½ and 2½ inch fire hose. (We have a reel hand drawn, loaded with 2½ inch hose at this school.) At the sound of the fire alarm the student firemen report to their stations both on the inside and outside of the building, and are in charge of all operations until the arrival of the city fire department. They also act as inspectors in and around the building and report any infraction of fire rules and regulations.

"Fire drills are not held at any given time in the schools, but there must be at least two drills each month in each school, and teachers or students are not notified as to when these drills will take place. The officials of the City Fire Department also go to these schools and hold fire drills at various times."

* * * * *

Fire Marshal Fleming of Ohio (Member N. F. P. A.), says that Mrs. O'Leary's famous Chicago cow has nothing on the animals in Ohio. In proof he offers this, from the Columbus *Dispatch* of March 1st, "The family cat at the residence of A. R. Jennings, 95 North Twentieth Street, Saturday afternoon walked under a hot-water tank, and when its tail caught fire, jumped into a waste-paper basket. A $20 fire resulted."

The Saskatchewan Fire Prevention Act and the Method of its Administration.*

By Arthur E. Fisher,
Fire Commissioner for Saskatchewan.

The Province of Saskatchewan was one of the first provinces to place on its statute books an act relating to the prevention and suppression of fires, the act having been passed in 1912. In substance it was practically a reproduction of the old Manitoba act and dealt almost entirely with the reporting and investigation of fires that might occur within the province. Under its provisions a Fire Commissioner could be appointed, his duties being stated in the enactment. In 1913 a Fire Commissioner was appointed and the administration of the Act was commenced.

During the following two years the Fire Commissioner's work comprised almost entirely the investigation of fires that seemed to be of a suspicious origin. Very little attention was paid to the prevention of fires, the Act being administered by one man, who of necessity could not devote much time to this all-important phase of the Fire Commissioner's office.

In 1915 the Government of the Province of Saskatchewan decided that the work of the Fire Commissioner's office and that of the Superintendent of Insurance were closely connected, and accordingly arrangements were made for the uniting of the two offices under the name of the Insurance Department. It was decided that more attention should be paid to the question of fire prevention rather than to the investigation of fires, which decision necessitated the preparation of a new fire prevention act. In 1916 a new Act relating to the prevention and suppression of fires was passed by the Legislature, the measure coming into force on June 1st, 1916, and it is under the provisions of this latter Act that the fire prevention work in the Province of Saskatchewan is being carried on at the present time.

The Act in its opening sections deals with the appointment of certain officials, viz.:—the fire commissioner, a deputy fire commissioner, an inspector and such other officers and clerks as may be decided necessary for properly carrying out the provisions of the Act. One of the most important sections is section 5, which reads as follows:—

> "5. The chief of the fire department of every city, town and village in which a fire department is established, and the mayor of any town or the overseer of any village where no fire department exists, and the secretary-treasurer of each rural municipality, shall be by virtue of his office a local assistant to the fire commissioner and subject to his directions in carrying out the provisions hereof within the limits of his jurisdiction, and shall also

*From an address to the Dominion Association of Fire Chiefs.

perform such other duties as may be imposed upon him in connection with the prevention of fire or inspection of buildings by the by-laws of the municipality."

Thus you see local assistants to the Fire Commissioner are appointed in every place, and it will be noted in reading the Act that they have practically all the powers granted the Fire Commissioner himself, except the investigation of fires under oath and the consideration of appeals against orders which may have been issued relative to the remedying of conditions. In other words, a local assistant has not only got the advantage of local by-laws to assist him in his work of fire prevention and inspection, but also the powers granted him under the provincial act. This is certainly a great advantage to any fire chief who is active in the work of fire prevention, as he has at his disposal the machinery of the provincial act if perchance the local municipal council has not adopted any by-laws relative to this important subject.

Officials and Powers.

I have already mentioned the officials named by the Act,—the Fire Commissioner, Deputy Fire Commissioner, Inspectors and Local Assistants to the Fire Commissioner. The Fire Commissioner is required to enforce all the laws of the Province and regulations made thereunder relative to:—

(a) The prevention of fires;
(b) The storage, sale and use of combustibles and explosives;
(c) The installation and maintenance of automatic or other fire alarm systems and fire extinguishing equipment;
(d) The means and adequacy of exit, in case of fire, from factories, asylums, hospitals, churches, schools, halls, theatres, amphitheatres, and all other places in which numbers of persons work, live, or congregate from time to time for any purpose;
(e) The construction, maintenance and regulation of fire escapes;
(f) The suppression of arson and investigation of the cause, origin and circumstances of fire.

The deputy acts in the stead of the Fire Commissioner or in the absence of the latter, and where conducting an investigation has all the power and authority of the Fire Commissioner. The inspectors have power to enter and inspect buildings, including their contents and occupancies, and report to the Fire Commissioner any faulty or dangerous conditions which are especially liable to result in fire or which endanger buildings or property adjacent. The local assistants carry out the duties of the Fire Commissioner (except the investigation of fires under oath) and the inspectors within the limits of their jurisdiction.

Investigation of Fires.

The local assistant is required to investigate or get information on every fire occurring within the limit of his jurisdiction with a special view of ascertaining whether the fire was the result of negligence, carelessness, accident or design. This investigation is to commence within three days of its occurrence. Immediately after such investigation a report is to be sent to the Fire Commissioner, the form for such report being attached herewith as exhibit "A."* Authority is given the local

* See page 339.

assistant to enter and examine any building where a fire has occurred and also other buildings adjoining deemed necessary in connection with the investigation. The local assistant is paid fifty cents for each fire reported by him to the satisfaction of the Fire Commissioner, and in the case of secretary-treasurers of municipalities in addition mileage at the rate of ten cents per mile travelled to and from the place of fire. The investigation mentioned is of a general character and is not under oath.

In case the Fire Commissioner causes any particular fire to be investigated under oath, he or his deputy may summon witnesses to appear before him, and may require such witnesses to give evidence orally or in writing, and to produce such documents and things as he may deem requisite to the full investigation of the matter under inquiry, and he has the same power to enforce the attendance of witnesses and to compel them to give evidence as is vested in any court of record in civil cases.

If as a result of the reports of the investigators the Fire Commissioner is of the opinion that there is sufficient evidence to charge any person with arson or attempted arson, the matter is handed over to the Attorney-General's Department for prosecution. However, as arson is a matter of the Criminal Code of Canada, there is nothing to prevent direct action being taken by either the local or provincial police forces.

In connection with the investigation of fires the local assistants as a rule are carrying out the provisions of the Act satisfactorily. Very complete reports are given by them. The department does not investigate every fire, but is guided by the reports filed in determining the advisability of a more thorough investigation into the cause of any fire.

The Inspection of Buildings.

While the investigation of fires has its moral effect and consequently has a tendency to reduce fire waste, yet it is through the inspection of property that the great work of fire prevention can be done. This inspection should be individual, but unfortunately the superimposition of this work on the state through its Fire Commissioner or upon the municipality through the local assistant seems at the present time to be the only effective means until such time as a campaign of education along the lines of individual responsibility shall have borne fruit.

Sections 12 to 16, inclusive, of our Act deal with this phase of the Fire Commissioner's work. Sections 12 and 13 are quoted:

> "12. The Fire Commissioner, his deputy, the inspector or local assistants, upon complaint of any person interested, or, when he or they deem it necessary without such complaint, shall inspect all buildings and premises within their jurisdiction, and for such purpose may at all reasonable hours enter into and upon any such buildings or premises.
>
> "13. Whenever any of the said officers shall find a building or other structure, which, for want of proper repair, or by reason of age and dilapidated condition or for any cause, is especially liable to fire, and which is so situated as to endanger other buildings or property therein, and whenever any such officer shall find a building or upon premises combustible or explosive material, or inflammable conditions dangerous to the safety of said building or premises, he shall order the same to be removed or remedied, and such order shall be complied with by the owner or occupant of said buildings or premises."

You can see at a glance the power that is given the local assistant who is active in the work of keeping his city, town or village in good shape as regards fire hazards. He is allowed to inspect buildings and premises within the limits of his jurisdiction either on his own initiative or upon complaint of any person interested. Every local assistant has in his possession an order book (exhibit "B")* on which he issues the order to remedy the unsatisfactory conditions that exist on a person's property. A copy is forwarded to the Fire Commissioner's office and a record is kept of the order and also a record regarding its fulfillment. A person in any of our cities, towns or villages who is anxiously safeguarding his own property may complain to the local assistant regarding the condition of his neighbor's premises. The machinery of the law is provided for this purpose, and I am pleased to say that through the influence of the educational campaign that is being waged in this Province many orders are being issued by our local assistants independent of the Fire Commissioner's office.

May I briefly outline to you the work of the Saskatchewan department along the lines of inspection?

In our department there are six inspectors available, one of whom speaks a majority of the languages of the foreign population of this country. These men visit every town and village in the Province calling on the local assistant and with him, if possible, making an inspection of the business and residential portion of the town. Orders are issued if necessary, making use of the order forms. On the conclusion of the inspection a report on the form supplied (exhibit "C")† is made out, a copy of which is left with the local assistant, the original being mailed to the department. When all the orders have been completed the copy left with the local assistant is returned to this office duly signed by him. In many cases no orders are issued, the owner being shown the advisability of the improving of the particular condition and at once setting about to carry out the suggestions made.

A "follow-up-order" man follows about two weeks after the visit of the inspectors to see that the orders have been duly carried out.

In order not to conflict with local municipal by-laws our inspectors in visiting a town where there are local fire prevention by-laws work in conjunction with the local official in whose hands rests the administration of the municipal by-law. Our inspectors do not visit any of the cities where there are paid chiefs, as the department knows that these men are active fire preventionists and devote much of their time to the all-important work of inspection.

It is not uncommon for this office to receive complaints from citizens. These are immediately acted upon either through the local assistant or by the department itself, there generally being an inspector remaining in the office for just such purposes. I may state that the storage of gasoline is the principal cause of the complaints referred to.

Penalties.

To render the Act effective certain penalties have been imposed. Anyone hindering the officials in the execution of their duties under the

*See page 341.
†See page 342.

Act or who refuses or neglects to obey a summons for appearance at an investigation is liable on conviction to a penalty of not less than ten dollars and not more than fifty. Any owner or occupant of buildings or premises who fails to carry out an order for the remedying of conditions is liable on conviction to a penalty of not less than ten dollars and not more than twenty-five for each day's neglect or failure to comply with such order. The local assistant who refuses or neglects to comply with the requirements of the Act is liable to a penalty of not less than ten dollars and not more than twenty.

Occasionally my inspectors have been obliged to show the property owner these sections of the law, but this is rare. My inspectors are instructed to use "moral suasion" and to show the owner the advantages to himself and the community of complying with the remedying order. This method is educational and at the same time effective. There is a commendable willingness on the part of the people of this Province to improve conditions when once the necessity of such has been brought to their attention.

Briefly speaking, the Saskatchewan Fire Commissioner's office is performing two duties: (1) The administration of the Fire Prevention Act; and (2) conducting a publicity campaign on the subject of fire prevention.

I have already outlined on general terms the manner of carrying out the provisions of the Statute. May I dwell briefly on the other work?

Only by a campaign of publicity and by education can the carelessness of our citizens in matters of fire hazards be eliminated or at any rate reduced. If people would forget that old belief that in the case of a fire the insurance companies will pay the loss, and instead remember that it is your money and mine that is paying the losses, the insurance companies simply acting as clearing houses, then a step would be taken in the right direction. Our fire losses would undoubtedly be reduced, because when you touch a man's pocket you touch his heart. It is necessary that the misconception of insurance be removed. It is also necessary to draw the attention of the people to the ravages of the monster carelessness. Bulletins must be issued and the services of the newspapers secured to give the subject widespread publicity.

Our Saskatchewan newspapers are certainly assisting the department in this respect. Many of our larger mercantile firms with extensive correspondence are enclosing copies of our leaflets in every letter that they send out. Many of our teachers are having talks with their pupils on the subject, a special bulletin having been issued to the teachers on the subject. All our public speakers in the greater production campaign throughout the Province this year touched on the matter of fire prevention.

The call for conservation of foods, etc., involves the conservation of existing assets. Every one who is a conservationist at heart is also a fire preventionist. Consequently there is at the present time a kindly feeling on the part of the people towards the subject which makes the

work of the Fire Commissioner's office much easier than it otherwise would be, and results are being obtained in the great clean-up movement.

I am sure that every fire chief present, were he to test the feeling of the citizens of his city, town or village, would find that the same feeling exists as in Saskatchewan.

(Exhibit "A")

REPORT TO THE FIRE COMMISSIONER

Province of Saskatchewan.

Confidential

City, town, village.....Street and number.....
Rural municipality of.....Location of fire.....
Name of owner.....P. O. address.....
Name of occupant.....
Date of fire.....Hour of fire.....
Kind of structure { Wood / Brick / Stone / Concrete } .....Kind of roof.....
How occupied { Dwelling / Store / Manufactory / Barn / Other purposes } .....
(State plainly kind of business carried on or nature of occupancy)
Fire started in.....
(State plainly in what part of building fire started)
Alarm given by.....

Building		**Contents**	
Estimated value of building	$.....	Estimated value of contents	$.....
Estimated damage to "	$.....	Estimated damage to "	$.....
Insurance on "	$.....	Insurance on "	$.....

Name of insurance companies.....

Cause of Fire—(Give facts in full).

.....
.....
Chief of Fire Department.
.....
Local Assistant to Fire Commissioner.
Date mailed.....Address.....

[OVER]

(Perforated here)

ORIGINAL

Debit Slip. Folio.....

FIRE COMMISSIONER

REGINA, SASK.

City, town or village.....
Rural municipality.....
Herewith please find report of fire occurring the....day of.....191..
.....miles travelled to location of fire at 10 cents per mile.....$.....
Fee allowed at 50c. for each fire.$.....
Total for mileage and fee.....$.....
.....
Mayor or Chief of Fire Department.
.....
Sec.-Treas. of Municipality.
P. O. address.....

N.B.—Keep one copy of this report for your file. Report must be satisfactory. Note section 7, subsection (4), of The Fire Prevention Act.

Approved .....

(Exhibit "A"—Reverse side.)

Fire Casualties.

Give name and address of persons burned:

.....
.....
.....

Give name and address of persons injured:

.....
.....
.....

Further remarks (use if necessary):

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

Notice.

State the circumstances of the fire, indicating how and where it originated, and any other material facts.

If suspicious of incendiary origin, state the grounds for suspicion and mention date insurance was taken out.

Indicating the Cause of the Fire.

"Carelessness" cannot be accepted as a cause of a fire, because all fires save those from an adjoining fire, incendiarism and lightning result from carelessness.

"Adjoining fire" applies in all cases in which the burning of a nearby building is the cause.

"Burning rubbish" indicates the cause to have been sparks from a pile of rubbish which was being burned to get rid of it, while "rubbish burning" indicates that sparks of fire lighted rubbish.

"Overheated stove" is not explicit enough. What was ignited by it should be stated. A sound stove properly placed and protected cannot burn a house by being overheated.

"Sparks." Tell the source of the spark and what it ignited. If from an engine it should be shown if it came from a locomotive, or a traction or a stationary engine.

"Lightning" being the cause, give answers to the following questions: Did the building have a lightning rod on it? If it was rodded, how long has the rod been up? What kind of metal was it? Whose make was it? What agent put it up? Was it in good repair? How was it grounded? Did it have two ends in the ground?

"Spontaneous combustion." Tell the material in which it occurred and the conditions as to ventilation.

"Gasoline." All gasoline fires start with an explosion. In every case state exactly how the gasoline was being used and tell what flame started the explosion. If it was in a stove or lamp, tell the kind and name of maker if possible.

(Exhibit "B")

(Perforated here)

Name of Owner.....: of Occupant.....
Address .....
Correct defects as follows.....
.....
.....
Date of issue.....Date of expiry of order.....
.....
(Signature)

Mail to Fire Commissioner, Regina.

(Perforated here)

Office of the Fire Commissioner, Regina.

ORDER TO REMEDY CONDITIONS.

Town }
Village } ....., Municipality .....
Street Address ....., Location .....
Owner ....., Occupant .....
Occupancy ....., Kind of structure.....
Correct defects from Fire Prevention standpoint as follows.....
.....
.....within.....days from date hereof.
This order issued under the { Fire Prevention Act. / Local By-law.
Order issued to.....
Date order was issued.....
....
Inspector Local Assistant

Failure to comply with the order of the Fire Commissioner, his deputy, the Inspector, or a local assistant subjects the owner or occupant to a penalty of not less than $10 and not more than $25 for each day's neglect or failure to comply therewith.—Section 21, Fire Prevention Act.

If owner or occupant considers himself aggrieved, appeal may be made to the Fire Commissioner at Regina, within 48 hours.

(Corresponding leaf for office record.)

Name of Owner.....: of Occupant.....
Address .....
Correct defects as follows.....
.....
.....
Date of issue.....Date of expiry of order.....
.....
(Signature)

Office of the Fire Commissioner, Regina.

ORDER TO REMEDY CONDITIONS.

Town { .....,
Village } ....., Municipality .....
Street Address ....., Location .....
Owner ....., Occupant .....
Occupancy ....., Kind of Structure.....
Correct defects from Fire Prevention standpoint as follows.....
.....
.....within.....days from date hereof.

(Exhibit "B" continued)

This order issued under the { Fire Prevention Act. / Local By-law.

Order issued to.....

Date order was issued.....

.....

Inspector Local Assistant

Failure to comply with the order of the Fire Commissioner. his deputy, the Inspector, or a local assistant subjects the owner or occupant to a penalty of not less than $10 and not more than $25 for each day's neglect or failure to comply therewith.—Section 21, Fire Prevention Act.

If owner or occupant considers himself aggrieved, appeal may be made to the Fire Commissioner at Regina, within 48 hours.

(Exhibit "C")

GOVERNMENT OF THE PROVINCE OF SASKATCHEWAN.

Office of the Fire Commissioner

INSPECTION REPORT.

Date.....

Town or Village.....

Mayor..... Overseer.....

Fire Chief .....

Condition of mercantile area.....

.....

Condition of residential area.....

Public Halls .....Exits.....Heating.....

Lighting .....Remarks.....

.....

Fire Equipment and condition.....

.....

Water supply.....

Brigade .....

By-laws re Fire Prevention.....

.....

Gasoline—No. handling.....Method of Distribution.....

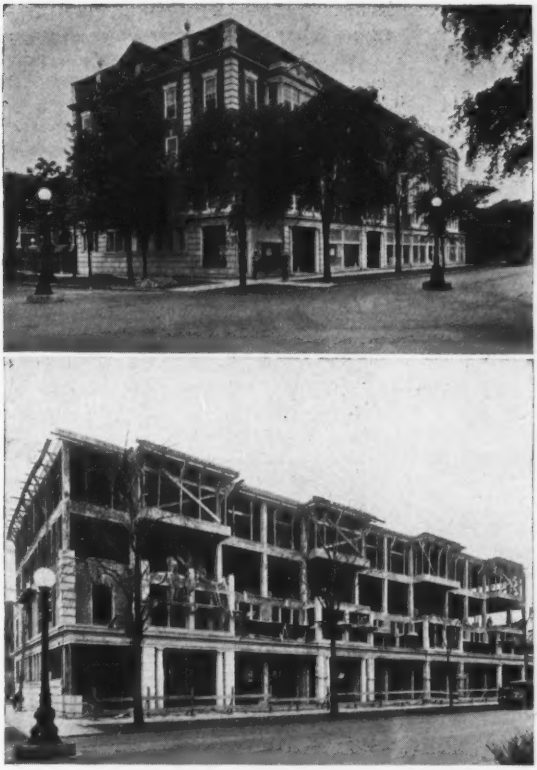
.....

Storage of gasoline.....

Order issued:—

NAME	EXPIRY	ORDER	WHEN COMPLIED WITH

Inspector Local Assistant



Junius Apartments and Shops, Chicago.
Junius Apartments under construction.

Fire-resistive Construction Cheaper in First Cost.

In a letter to CONCRETE, March, 1919, in which he comments on the relatively low cost of fire-resistive building construction in these times, as compared with non-fire-resistive construction, Henry K. Holsman, architect, Chicago, refers to the Junius apartments and shops shown in the accompanying illustration.

The same owner had a building erected on the same line six years prior to the erection of this building. The earlier building was the same length, three stories and low basement, instead of four stories in height, finished on two sides instead of three sides, and built in the ordinary manner with brick exterior walls, wood joists, wood studs, etc. The units in the old building were practically the same as those of the new and were designed for the same purpose, namely, apartments.

The new building is fire-resistive, throughout, except that the roof is of frame construction built over fire-resistive slab, forming the ceiling of the top story. The new building is composed of better material throughout, and yet its cost per cubic foot was nearly 4 cents less than the cost of the old building.

This was done in spite of the fact that the market price of steel was at its highest point, namely, $72 a ton at the mill. Reinforced concrete frame construction was used, the exterior wall being curtain walls of hollow building tile faced on the outside with shale brick. Stairs were built of iron with concrete treads and wood rails.

The floor construction in the newer fire-resistive building is of the concrete beam type, with removable steel dome. The building under construction is shown in one of the illustrations.

Another interesting feature is that the building contains 43 concrete mantles made of a portland cement, sand and color mixture, of a composition to give a Caen stone appearance. The mantles were made in one piece and by having 43 of them made on one order, in one factory, it was possible to get them installed at a price of $17.50 each. They are better than wood mantles and are, of course, much more economical, both as to first cost and upkeep.

The lobby of the building has a concrete mantle of more elaborate design.

The remarkable difference in the cost of the two buildings could easily be accounted for, and this difference would have been much greater had the two buildings been built at the same time. In the fire-resistive building there was no wood trim whatever used around any of the windows, and the wood finish and trim throughout the building was reduced to a minimum. Where heavy brick walls were required between the units in the building of ordinary construction, 3-inch tile was used in the fire-resistive building. Of course, the floor construction in the fire-resistive building was much more expensive than the floor construction in the ordinary building, but almost every other feature of the building was much less expensive in the fire-resistive building.

My experience in changing plans from ordinary construction to fire-resistive construction, after taking bids on the ordinary construction, leads me to say that if the designer will give due consideration to the points of difference between the two types of construction he will find that, as the markets now are for buildings of this type, fire-resistive construction will cost no more than ordinary construction. I think the reason this is not more generally understood is because when the architect usually designs a fire-resistive building he uses all of the features of the ordinary construction and adds to them the fire-resistive construction. This is not necessary, and, in fact, not desirable.

Features of Fire Hazard in Airplane Manufacture.

By W. D. Milne,

(Member N. F. P. A.)

Superintendent of Surveys, Underwriters' Bureau of New England.

During the latter months of the recent war the airplane factories in this country had reached such a point of development that they were prepared to produce planes in great number. The conditions incident to large quantity production contained much of interest to the fire protection engineer that is not present in the conditions surrounding the small scale manufacture of airplanes. It seems likely that a long time will elapse before the commercial demand for airplanes will at all approach in magnitude the recent war demand. We may, however, with profit, review some of the features of fire hazard found in the airplane factories under war-time conditions.

Under the stress of such conditions the provision of modern equipment for protection against fire in manufacturing plants was in many cases neglected. In few, if any, cases did the installation of such equipment proceed simultaneously with the provision of the buildings. Lack of appreciation of the hazard of the plants or of the effectiveness of modern sprinkler systems resulted often in the delay, or the omission of automatic sprinkler protection. The same may be said in regard to the plants created to produce other classes of war material.

In the protection of plants supplying war material in war time no pains should be spared to prevent interruption of production by reason of fire even for a single day. It appears to be a fact, however, that the success of America's airplane enterprise was unnecessarily jeopardized at times by the lack of provision of adequate means of protection against fire in the producing plants, and that disaster was escaped mainly through good fortune or the early closing of hostilities. While we may regret the defects of protection, from the standpoint of the best engineering practice, in America's airplane plants, it is only fair to say that the guarding and the housekeeping in such plants received good attention along lines of military discipline, and that this did much to avert disaster.

Taken as a whole, the history of America's effort in airplane production is a marvellous record of human energy and of the application of formerly unrealized resources of materials and technical knowledge, and in spite of popular opinion to the contrary, it reflects much credit upon the men engaged in the work. While the need for the airplane weapon was removed before the effort had reached its intended result, and millions of money therefore appeared to have been spent in vain, America's manufacturing industries learned many valuable lessons from that effort; many advances were made in technical knowledge; the gaso-

lene motor was more highly developed, and new uses and methods of use and handling of many materials were instituted all in the course of a few months. We trust also that through the efforts of the fire protection interests in war time, manufacturers and the public learned somewhat as to conservation that will in time repay a part of this cost of war.

For the various parts which enter into a completed airplane many industries were called upon, among them the chemical, textile, woodworking, metal-working, machine shop and electrical industries. Of the great plants created for the war-time need, there were two principal classes: first, those in which the motors, or engines, were made, and second, those for the building of the body and planes of the craft itself.

In the following paragraphs the writer has endeavored to present as briefly as may be some notes on the more prominent hazards only as observed in the limited number of large, new plants of this sort which it was his privilege to visit during the war period.

Airplane Motors.

The airplane motor is comparable with an automobile motor in so far as the processes of its manufacture are concerned. The existing automobile manufacturing organizations and factories were very largely utilized in the making of airplane motors, and although certain adaptations of machinery were made, and the plants were put under much pressure to obtain speed in production, few new special hazards were introduced.

The "speeding up" of manufacturing operations, night work, and less discrimination in the employment of labor, of course, added to the severity of the normal hazards, while the demand for production brought about the toleration of certain hazardous conditions that otherwise would not have been permitted to exist.

Cleaning.

In the final stages of the assembly of the main working parts of a motor a thorough cleaning is necessary. This is frequently done with gasolene, applied both by dip tank and air spray methods. The fire hazard involved in this process, especially as large quantities of gasolene are used, is so evident that we should expect this work to be carried on only in isolated and specially protected rooms. Despite the hazard, however, the process is known to have been carried on in large and crowded workrooms, without special protection for electric motors, wiring, etc., and without reliable means for quick extinguishment of fire.

Motor Testing

Airplane motors undergo elaborate individual tests before leaving the factory. They are tested under conditions closely simulating those obtaining in actual flight, the propeller being attached and the motor mounted either on an airplane chassis or on a "block," the whole being set in the open where free flow of air to and from the propeller is possible.

In a factory producing a number of motors daily, twenty or more motors may be undergoing test at one time, the oily conditions of testing stands and the necessary presence of gasolene in quantity creating serious hazard. In certain tests the fuel consumption is measured, and gasolene

reservoirs are sometimes mounted on scales above the testing stand. The arrangement may be a 50-gallon drum above each stand, feeding by gravity to the motor. Fire may occur by back-firing of motors or from other cause. The repeated use of the testing stand results in oily conditions, while the quantity of gasoline present makes a severe fire possible, especially if the testing stands are in close proximity to each other.

Testing installations should be located if possible in an open field at a distance from buildings. Each stand should be separated from the next by a brick, tile or concrete wall, and any roof should be of metal or other non-combustible material. Testing areas inside buildings, if necessary, should be as small as practicable, should be well cut off from adjoining buildings, and should be equipped with automatic sprinklers. In any case, a liberal supply of hand extinguishing apparatus should be provided and constant care as to cleanliness exercised.

Airplane Factories.

For the building of airplane bodies and wings for war use a number of extensive plants were erected in this country. Certain characteristics of these plants and of their occupancy place them in a class by themselves, although in a broad way they may be classified as woodworkers.

The most striking feature of these plants as a class is the presence of very large unbroken areas. Large open areas, well lighted, appear to be necessary to the work, if it is done on a large scale. A completed plane may have a wing spread of from 40 to 90 feet or more, and for the assembly and movement of such large objects much room is necessary. Areas under one roof frequently exceed 100,000 square feet.

The buildings were erected hastily in the emergency, and additions were made rapidly. The usual type of construction consists of one-story buildings with light steel framing and roof trusses, with plank roof having raised monitors. The provision of adequate fire stops was frequently neglected, while the use of steel framing rigidly connected over large areas made extensive collapse entirely possible in case of fire.

Regardless of the specific occupancy, buildings of this general type housing vital industries should be fully equipped with automatic sprinklers having powerful water supply, while as many walls as possible should be provided. In the airplane plants in quantity production these large areas are filled with combustible material so arranged that the spread of a fire would be exceedingly rapid. These two conditions, large areas and combustible contents, in the event of fire would put to severe test any form of protection provided, and exceptional water supplies are necessary for the sprinklers and hose if reliance is to be placed upon these forms of protection.

In order to appreciate the necessity for powerful means of defense against fire, we must visualize the large areas of an airplane plant with their contents in the form of light wooden parts and structures of planes, and at the same time bear in mind the attendant manufacturing hazards.

The fact that areas are large and roofs are well elevated and supported on steel work seems to convince the lay mind that the danger of

disastrous fire is remote. Experience, however, has repeatedly shown that a fire, once it attacks an extensive roof, is exceedingly difficult to control, even by powerful hose streams in great number, and that in such fires steel work supporting the roof quickly softens and collapses, and severe loss results.

In the design of an airplane plant especial effort should be made to secure subdivision of the working areas so that the portion to be affected by one fire shall be as small as practicable. Any effort in the extinguishment of fire becomes more quickly effective if it can be concentrated in a small area. Metal fire curtains extending from bottom of roof trusses to roof planking, erected at intervals, may be provided in existing buildings of large area to check the spread of fire along the roof and to accelerate the action of sprinklers through the stopping of horizontal drafts. Fire curtains are, however, somewhat of a makeshift, and their use in a new plant should not be necessary. By providing fire walls parallel with the direction of progress of material through the plant, as well as at such intervals in the transverse direction as may be practicable by reason of distinct steps in the manufacturing processes, the necessary area subject to one fire even in a very large plant may be materially reduced.

Lumber Storage.

The building of airplanes in large numbers requires a large supply of specially selected lumber. This lumber should, of course, be so located that the piles do not form a threatening exposure to the manufacturing buildings, and ample hydrant protection should be provided for the storage area. Furthermore, to afford protection against interruption of operations the lumber yard should be so divided that all the stock will not be subject to loss in one fire.

Dry Kilns.

During the war rigid specifications were made by the government engineers regarding the kiln drying of lumber for airplanes, and a special design for moist air kilns was developed. While the fire hazard of this type of kiln appears to be relatively light, the importance of the work demanded that only the best fire-resistive construction be used, and that sprinkler protection be provided. Good practice requires that dry kilns with their large masses of contained lumber should, if possible, be in detached locations, or well cut off from manufacturing areas, instead of in interior locations, difficult of access. The old practice, more or less common among small woodworkers, of locating dry rooms above boiler rooms is believed to be an evil one from the point of view of fire hazard.

Woodworking Plant.

The various surfaces of an airplane have an interior framework built up by an intricate assembly of many small wooden parts, designed to secure maximum strength and rigidity with a minimum of weight. The number of the parts, their intricacy, and the ingenuity with which they are made and fitted are a source of surprise to one familiar only with the external appearance of the finished plane.

The manufacture of the many wooden parts involves more or less ordinary woodworking processes, but on account of the nature of the work, and the necessity for rejection of imperfect material and imperfect work, the amount of wood waste produced is very large. It is, of course, more than ordinarily imperative that adequate blower systems be provided for the removal of the waste, and that removal of heavy waste by hand be given careful attention. In a modern woodworking plant the sawdust collectors and bins and the boilers themselves are, of course, housed in structures of fire-resistive material isolated or effectively cut off from other buildings.

The woodworking processes on small parts are to a large extent independent of the later assembling processes, and there is no reason why this department of the factory should not be effectively cut off by brick walls, largely blank, from other manufacturing and storage areas.

Frame Assembly.

In the assembling department the frames of the various surfaces are built up. Glueing, fitting and varnishing are incidental processes, and except in the quantity of light wooden framework likely to be present, the occupancy is similar in its hazard to that of an ordinary woodworker.

Work in this department is divided between that for wing, elevator and other flat surfaces and that for the body or "fusilage" of the plane. The latter is a long, box-like truss stiffly built up of wooden struts and wire tension members.

In connection with this and other assembly work on frames and the machine, as it approaches completion, we have soldering and brazing of certain of the metal members. This entails the use of a flame (gasoline soldering kit furnaces are used), and involves an appreciable hazard, due to the handling of the stoves in proximity to large amounts of combustible material.

While we cannot here go into details concerning the construction of various types of airplanes, it may be well to distinguish between the so-called sea-planes or "flying boats" and the "land" types. The sea-plane has usually a relatively heavy and roomy boat-like body, designed to rest on the water, and of quite different construction from the light skeleton structure of the fusilage of the land plane. In the sea-plane the motor is not mounted in the boat, but above it, and the boat is of sturdy design, built after the manner of a canoe, strong enough to resist the usual stresses set up on landing and shaped to glide easily on the water. In the land plane the motor is usually mounted directly in the nose of the fusilage, rubber-tired wire wheels being provided to receive the shock of landing, and to allow the machine to travel rapidly on the ground before "taking off" or after alighting. The building of the sea-plane body involves somewhat more woodwork than does the other, but the hazards are the same.

Wing and Surface Covering.

The plane surface elements and most of the fusilage or "body" of an airplane are covered with tightly stretched cloth. High-grade linen

cloth was extensively used at first, but later strong, light cotton cloth was found to be suitable as well as much less expensive.

The cloth working, involving cutting, sewing and fitting, although a very important part of the whole operation, involves relatively light hazard. The accurate cutting and fitting of the enveloping cloth to the frame requires skill and care. Women are largely employed in this department. There is no necessity that the work of cutting and stitching cloth be carried on in the same room with other processes. It should therefore be done in a cut-off area in order that the size of the main areas subject to one fire may be reduced and the values in one section kept as small as possible.

"Doping."

After cloth has been tightly stretched on the frame, it is treated with several coats of "dope" or varnish, and lastly, sometimes, with a flat paint. The "dope" has the effect of making the cloth taut, and renders it smooth and weatherproof.

The "dope" itself, the process of applying it, and the presence of freshly doped surfaces of large area introduce a distinct and severe hazard calling for special measures of protection.

The "dope" consists of cellulose nitrate or cellulose acetate dissolved almost always in a volatile and inflammable solvent.

Both the acetate and nitro-cellulose "dope" are hazardous when wet with the solvent, partaking of the hazard of the solvent. The nitro-cellulose "dope," however, is the more hazardous when wet, and is also very hazardous when dry, the film which it presents on the coated surface being akin to celluloid in respect of hazard. The dried acetate "dope" does not burn freely, being similar in composition to the slow-burning acetate type of moving picture film. The acetate "dope" was used for fighting planes, but owing to the shortage of this material the hazardous nitrate "dope" was largely used on the many training planes produced in this country. It is doubtful if the nitrate "dope" will be again used on account of the fire danger to which its use exposes the completed plane.

The "dope" used should be stored only in detached fire-resistive buildings, and should be brought into workrooms in covered containers of the smallest practicable size. Nitro-cellulose "dope" in quantity would in a fire burn at an exceedingly rapid rate, and at high temperatures in confined areas might give rise to explosion. The solvents used are various, and the exact compositions are largely trade secrets. Acetone, amyl acetate, alcohol, etc., are used. The only non-inflammable solvent used is tetra-chlor-ethane, the vapors of which are highly toxic, and this with alcohol has been used only to a small extent. The "doping" room in an airplane factory should be positively cut off by fire walls from all other sections, and in large plants should itself be subdivided into as small areas as may be practicable. Powerful fans and systems of ventilating pipes should be arranged to constantly draw the air from both near the floor and from points about eight feet above the floor. The forced ventilation should be kept in service at all times while surfaces are drying or "dope" is being applied. Scrupulous care of waste,

wiping rags, brushes and containers should be observed. That such rooms should be equipped with sprinklers and hand protection appliances is, of course, a prime necessity.

Heating by hot air, if drawn from outside buildings, is perhaps of less hazard than heating by steam, since steam pipes are a source of danger in connection with rags or spilled "dope." Electric light and power wiring and equipment should be arranged in accordance with standard rules for hazardous places.

Plane Assembling.

Assembling the surfaces with the fusilage, setting and adjusting the motor and its controls, upholstering and fitting the pilots' and observers' seats, equipping the plane with its telephone, machine gun, wireless apparatus and the other intricacies of modern invention require much expert and painstaking labor and result in a large accumulation of nearly finished planes in a single area. The main hazards of this work consist in this accumulation of machines in one place, and in the attendant processes of soldering, painting, etc.

Engine Testing.

After the motor has been set in the fusilage and the wiring and controls completed, tests of operation are made. This involves the handling of gasolene and the danger of motor back-firing. Testing should be done only in a cut-off area, or outside, and never in large workrooms or in proximity to combustible material.

Metal Work.

No mention has been made of the metal work involved in the manufacture of the numerous special articles of hardware which enter into the construction of the plane. Although such goods are usually purchased from other factories, some airplane factories manufacture their own hardware, and complete brass casting and machine processes for this purpose, presses for making engine beds, cowls, etc., may be found. These processes involve the hazards usual to metal workers and require no special comment. Much, if not all, of the hardware is of special design, and consequently it cannot readily be obtained in quantity in war time. Therefore the protection of plants manufacturing such material is also of vital importance.

Boxing.

For shipment airplanes are to some extent dis-assembled. Wings and other flat surfaces are taken off and the fusilage stripped of projections. The fusilage and the flat surfaces are then nested and crated in a stiff, specially prepared wooden box, careful protection by paper and other material being provided. For over-seas shipments elaborate precautions are taken.

The packing cases are necessarily bulky, and the presence of many of them, with their accompanying packing materials, in the shipping room of a factory results in an accumulation of highly combustible material.

Conclusions.

In view of the magnitude and importance which the airplane industry had attained in the fall of 1918, the study of the proper methods for defense against fire in factories of this class would appear to be deserving exhaustive attention. The conditions which then prevailed no longer exist, and it is possible that before airplane production again reaches great volume the processes and materials, and consequently the fire hazard involved, will have radically changed.

The lesson to be learned from the war-time experience in creating plants for the production of goods is that it is sound economy to incorporate in the plans for such plants the measures necessary or desirable for their protection against fire, and in the construction of the plants to provide simultaneously with the buildings the necessary equipment to protect them. In the planning of new, modern cotton mills, there are well-established rules or considerations for fire protection especially adapted for that class of plant which are followed intelligently by construction engineers. In the less highly standardized classes of manufacturing plants little or no attention may be accorded by the designers or the builders to the provision of defense against fire. It is to be hoped that in the future engineers, production managers and owners contemplating construction will appreciate the value of considering their plans with a conception of the fire hazard to be expected, and will consult with those experienced in modern fire protection engineering practice.

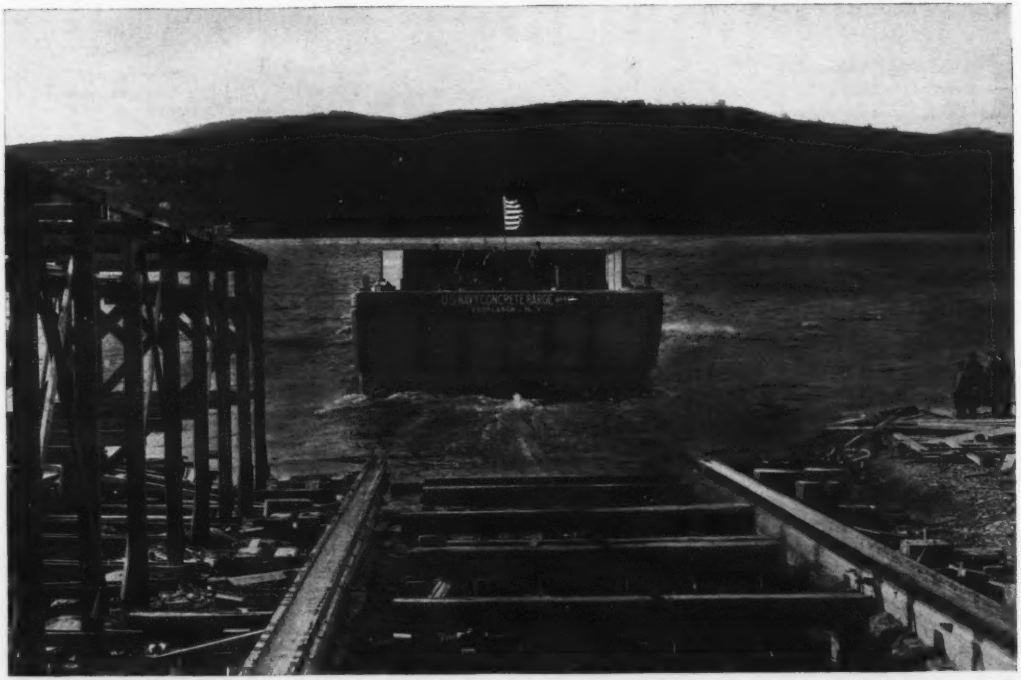
Fighting Fires in Ships.*

By District Chief Edward J. Shallow,

Boston Fire Department.

The subject of marine fire-fighting falls naturally into two parts: (1) The fighting of fires at sea by crews. (2) The fighting of fires on vessels at wharves or in harbors by city departments. The fighting of fires at sea by crews does not come within the scope of this paper, but there are matters in relation to this subject that the new shipbuilding program forces us to take into consideration. Every chief and every officer from a seaport is more or less familiar with sail and steam craft and their construction. But we are now being confronted with new types, not only of wood and steel, but also of concrete, of large size, and equipped with various new devices. Also electricity is coming into use for propulsion, which adds a new complication. So to keep up to the times would require a course in naval construction, which I think a great many of us would not care to take. The Federal Government is now standardizing ships so as to make as many interchangeable parts of a ship as possible, in order that, should a ship need a new part, any yard or shop could

*From a paper presented to the International Association of Fire Engineers.



Courtesy Portland Cement Association.

Launching of a 500-ton concrete barge built for the Navy Department. This barge is designed to carry either coal or oil. It is interesting to note that concrete is now being used not only for ship construction but also in the building of railway freight cars.

furnish that part without delay and at a minimum expense. This method has reached the highest point of efficiency in the automobile industry, and is the reason for the low-priced popular car. It should tend also to a great increase of the merchant marine, and we shall later find certain size and speed ships, designed especially for certain trade routes. The plans have not yet reached a stage at which they cannot be changed without much labor and confusion, and the thought arises that the Government might, if it be feasible, take part of the burden of fighting fires on ships from the shoulders of sailors and firemen, where it now exclusively rests, and place some of it where it belongs, on the owners.

On war vessels the officers of the deck, by looking at a dial on the bridge at any time, know the temperature of magazines, bunkers, etc. What an advantage to a merchant captain that would be! How much quicker a chief could get to work if, on arrival, he were told just where the fire was located. Let us say that there are certain sizes of standardized ships. Why should not Congress pass a law that owners must install devices to locate and control fires? Why not a sprinkler system and standpipes? The problem is simply a mechanical one, and the cost need not be excessive. If good on land, where help is quickly available, at sea, with an untrained crew and possible storm, it seems to me the appliances mentioned would be invaluable. Why should not every available means of locating and combatting fire on ships be taken advantage of by owners and underwriters? Conservation is the word now, and will be after the war, and such action should tend greatly to reduce the number of marine fires and save ships and probably, at times, life.

This brings us to the second part of the subject—the fighting of fires aboard ships at wharves or in harbors by city departments. The method of fighting fires on shipboard is determined in a great measure by the cargo, whether the vessel is partly or wholly laden, and how great a start the fire may have before the arrival of the apparatus. It is assumed that the fire must be fought almost wholly from the hatchways or from holes cut in the deck, in the case of a wooden vessel. On arrival, the first care is to locate the fire, find what the cargo consists of, and how laden. This is usually ascertained from the ship's officer in charge. If he is unable to give this information, we must be guided by the volume of smoke arising from the ventilators and the heat on adjacent parts. By these signs a shrewd guess can be made, but it is only a guess, and we may be mistaken. We then remove the covers of one or more hatches, as we think necessary, and turn the streams from fireboats and steamers into the hold. It is obvious that only in very rare cases are men ordered into the holds, and in dealing with explosives and certain other goods and chemicals that generate noxious fumes and gases, it would be impossible for men to enter. If the ship is loaded to the hatchway, the ship must be flooded to the point of the fire. If partly loaded, the streams may put out the fire on their way down, if the volume of fire is not too large, but it is safe to say that, in this case also, we must flood the ship to the point of contact with fire. As stated above, where fumes arise, the ship must be flooded from a safe distance

to avoid loss of life. In some cases it is advisable to open sea cocks, break ports and scuttle the ship, which is practically flooding it. Unlike fires ashore, there is little or no chance to remove the cargo and get at the actual seat of the fire, and it can be subdued only by actual weight of water or flooding. The writer does not know of anything yet designed, nor can he imagine anything to be invented, that would materially aid in the extinguishment of fires on shipboard under present conditions. In his opinion the only way to subdue a fire of any magnitude on shipboard is by flooding; he believes that this will be found in accordance with the experience of the majority of chiefs of seaport and lake departments.

Returning to the suggestion as to the use of sprinklers and standpipes, the writer believes their introduction on ships to be necessary and imperatively demanded now, and he suggests to this convention that a committee be appointed to draft a bill, to be placed before Congress and backed by this body, calling for the installation of apparatus to locate and extinguish fires on shipboard; the bill should be mandatory and carry a sufficient penalty to prevent evasion; it should include all new ships above certain sizes. Of course, compliance with the regulations made under such a law would cost the owners something, but if underwriters reduce insurance rates ashore when such apparatus is installed, they would surely be glad to do so on ships, and in that case the additional expense would in the long run be recovered.

The Importance to the Public of the Inspection of Interior Wiring.*

By William S. Boyd,
Secretary, Chicago Chapter, N. F. P. A.

We have on previous occasions considered the necessity for municipal supervision of electrical wiring, and I propose this year to present the subject from a slightly different viewpoint.

Carefully-kept statistics seem to indicate that defective wiring is still taking its heavy toll of property in uninspected districts, and this fact alone would warrant the application of rigid inspection to all interior wiring installations.

The tabulation of fire losses by causes made by the National Board of Fire Underwriters shows that, as a fire origin, electricity still maintains itself at the head of the list as a property destroyer, and I assume that this Association still deplores this unnecessary loss as a great misfortune, and pledges itself to the task of reducing its magnitude whenever and wherever possible.

A portion of the public realizes the importance of inspection of interior wiring, but the balance, and apparently the larger portion, does not. It is with a few general divisions of the former class that we shall concern ourselves in this discussion.

* Paper read before International Association of Municipal Electricians.

The Business Man's Estimate.

Let us first consider the attitude of the business man, and for two reasons:

(1) He was the first to adopt electricity for light or power purposes.

(2) His influence on inspection has the most far-reaching effect.

The first extensive introduction of electricity for interior illumination took place among the textile mills of New England, and its operation was immediately followed by numerous fires. In a group of sixty-five installations, twenty-three fires occurred within a period of six months. The managers of these plants thought, in the substitution of electricity for gas or oil as an illuminant, they had chosen the best and safest form of lighting available, but they soon learned that unless the wiring, appliances and machinery were properly installed and maintained a serious fire danger was likely to develop.

The insurance companies which paid these early losses were greatly alarmed, and sent a representative to consult with the manufacturers of the apparatus which caused the trouble, and after considerable study and experimentation, a set of rules was drafted which, on being enforced, put an end to the epidemic of fires in these plants. This took place in the year 1881.

These rules applied only to industrial plants, but others soon made their appearance which were of more general application. Some of these rules came from municipalities. The City of Chicago inaugurated inspection in 1880, but did not have any detailed rules until later. The ordinance, providing for the filing of application for permission to do electrical work, and requiring a certificate of inspection before wiring or apparatus could be put in service, did not pass till December 10th, 1883. The late C. C. Haskins, well known to the old-timers in the inspection work, was the first inspector Chicago ever had, and he remained in the service of the city for a great many years.

Electrical inspection departments were established by insurance organizations in the larger cities at an early date, the New York Board of Fire Underwriters being the first in the field with a set of rules dated 1881.

The conservative merchants and manufacturers were deterred from signing contracts for electric lighting plants by these early fires, and many of them continued with the oil and gas till assured by the representatives of insurance companies that it would be perfectly safe to use electric light if the plant were properly installed. Strenuous efforts were put forward by the electrical manufacturers to preach the gospel of safety to the business man, and when his fear gave way the use of electric light became quite general, and increasingly satisfactory. The business man kept pace with the progress of the art, and from time to time, as new systems were developed which were safer, he adopted them, and there are many manufacturing plants that have had as many as six or seven types of illuminating units, and in some cases several kinds have been in operation at one time. These changes in the form of light-

ing have not been made exclusively on account of the fire hazard involved, but in many cases because the lighting was not suitable or efficient, or because it was injurious to the eyesight of the operatives.

The advent of electric light made it possible for the factory manager to utilize portions of his building which before were of little or no service to him, and it permitted him to operate the plant at night, and thereby nearly double the output.

There were processes which could be carried on only in daylight, but with the appearance of the incandescent lamp it was possible to provide a reasonably safe form of lighting, especially for rooms in which inflammable gases were present, or in which there were combustible flyings. It has been the inspector's study of these problems that has developed these safeguards and made available the use of electricity in these locations.

The merchant at one time illuminated his show window by means of gas light, and when the incandescent lamp was presented for his consideration he ordered his windows equipped, but the plan followed brought the lamps into close proximity to inflammable material, and the lights were so placed as to hinder the prospective customer from properly viewing the display. The combined efforts of the inspector and the illuminating engineer eventually forced the lights into the upper portion of the window, and thereby achieved real illumination and the maximum of safety.

Instances of this sort could be multiplied indefinitely, and it has been service of this character that has given the electrical inspector in many cities such a good standing with the business man, that he refuses to make any move regarding changes in his electrical equipment without first consulting with the electrical inspector, whose decision in the matter generally settles the question at issue. The business man has found that he can rely upon the electrical inspector to protect his rights where an electrical equipment is being installed, and prevent his being imposed upon by incompetent or careless wiremen, and it is not strange that when the electrical inspector needs a friend, the business interests are quite solidly behind him. Many a politician has learned that it does pay for a public servant to be true to his trust, and that the faithful inspector cannot be displaced or hindered in his work with impunity. Need we go further for an expression of the business man's estimate of the importance to the public of inspection of interior wiring?

The Householder's Estimate.

Electricity for light, heat and power purposes came into the home very gradually. Many of the early installations consisted of but one or two lights, but with the invention of the integrating electric meter and the establishment of watt-hour in place of flat rates the service in the home became more general, until today we find that it has quite largely superseded gas and oil for the production of light and heat. Where the electrical public service company has been up-to-date in its policy, practically all of the new residences have been wired during the construction period.

In the early days a job was considered as wired properly when the

lights burned and were only occasionally extinguished by defects in the installation, such as broken wires, switches, sockets, etc. This view changed when the carelessly wired buildings began to be troubled with fires. These experiences had two results: they caused the electrical people to be more careful with their work in the town in which the fire occurred, and they caused a good many users of electricity in the neighborhood to cut off the current from the home, and others refused to have their homes connected until the wiring was inspected and pronounced safe, either by a representative of the lighting company or a regular electrical inspector.

Some of the early patrons of the lighting company were fearful of lightning and insisted on cutting off the current during every thunderstorm. This practice has been discontinued as better wiring and better lightning protection has been installed. This restored confidence is due to improved conditions resulting directly or indirectly from inspection and the trust imposed in the work of the inspector.

As the use of electricity in the home increased, there grew up certain practices which introduced fire dangers which had to be met by the inspector. The first lamp shades procurable were not very artistic, and paper shades were made and placed on the lamps, and in some instances the paper only charred, but did not ignite, while in others a small fire ensued, and the inspector's fight against the use of these shades was eventually successful as the danger accompanying their use became apparent. The glass and pottery shade manufacturers provided artistic shades to make the housewife happy, and at the same time eliminated the hazard of bringing inflammable material in contact with the lamp bulb.

The habit of bringing lighted matches and candles into clothes closets gave way to the closet light, and to prevent these from being left burning while in contact with clothing, the door switch was installed or lamp guards were provided.

The schoolboy experimentor was early on the scene with his magnet-wire and flexible cord contraptions and gave the lighting company its troubles, and this epidemic of tampering was only stamped out when the public service company threatened to cut off the current, or the inspector instituted criminal proceedings against the offenders. The inspector's publicity work in the newspapers helped call attention to this violation of the ordinance and its probable results.

Utilization equipment and devices began to appear on the market and later in the home, and some of these were decidedly dangerous, both because of defects within themselves and because the circuits on which they were to be used were not properly prepared for such attachment. The electrical inspector was ultimately able to control the situation while these devices were in the hands of the lighting company or the electrical contractor and did protect the customer to a great extent by inspection and newspaper publicity, but when the department stores, and especially the Five-and-Ten-Cent stores began to dabble in electrical goods, the inspector found a "foeman worthy of his steel," and special notice was served on these stores to handle only approved goods, and their stocks

were watched closely. In some cities the matter was handled through the adoption of an ordinance regulating the sale of electrical supplies and requiring the approval of the electrical inspector before any electrical material or device could be afforded for sale.

The acid test of the householder's estimate comes when he moves from a city or town which had municipal supervision of electrical wiring and takes up his residence in a city or town which is without such service. When the matter of electricity for light, heat or power is presented to him in the new home, his first question is: Will the inspector approve it—does the inspector think that this wiring is safe? And he is generally much disappointed when told that there is no inspection service available.

The Electrical Contractor's Estimate.

In the early days of electric lighting and power no one fought the establishment and enforcement of rules governing the installation, operation and maintenance of electrical wiring and apparatus more consistently and bitterly than did the old-time electrical contractors. They were almost a unit in saying that the proposed raising of the standard for wiring to bring it into harmony with the National Electrical Code would ruin the business, and no one would ever order electric light into his home or place of business at the price that must be asked under the proposed rules, and the electrical contractor would be obliged to shut up shop. A few months' experience with the enforcement of the rather crude rules of the early days soon dissipated the contractor's fears, and he gradually began to see that the rigid enforcement of the Code stabilized his business, enabled him to charge a fair price for his work, to use reliable material and fittings, to install the equipment in a workmanlike manner and thereby to provide his customers with a safe, reliable, adequate and efficient light or power installation. This, of course, put his business on a firm foundation and made it pleasant as well as profitable to do business. Now no one fights harder for rigid, impartial and competent inspection than does the honest electrical contractor. Those contractors who held to the old ways of "skinning the job" are long since out of business.

Under inspection the contractor could bid to do first-class work without fear of losing the contract to a dishonest bidder, and on being awarded the contract he could afford to do the work properly, and, after the installation was complete and in operation, he could feel certain that he could again call on this customer without being thrown out, and when extra work or repairs were needed he would be almost certain to get the work.

The only criticism the electrical contractor has to offer to the electrical inspection situation as it exists today is that there is a lack of uniformity in the interpretation of the National Electrical Code rules, and this condition is being gradually overcome. He has said something about special rules in different cities, but he does not object to special rules when he knows what they are and what they mean, and there should be no trouble about this detail with a competent inspector in charge of the work.

If the inspection of interior wiring should suddenly cease, a great industry would be shaken to its foundations, because it would be left without a standard, and an industry without a standard is like a ship without a compass. The National Electrical Code would cease to exist as a standard if it should cease to be enforced by inspection. The electrical contractor knows this, and that is why he is generally enthusiastic for inspection under an impartial inspector, and may always be counted upon to lend his influence to the cause of rigid enforcement of the National Electrical Code.

The Electrical Manufacturer's Estimate.

The early lighting outfits were series arc systems, and the fire-producing record of these early installations tended to create apprehension which led to restrictions confining their use to street-lighting for some time, and greatly impeded the progress of the companies manufacturing this type of apparatus. The development of rules for the safe installation of these systems and inspection under them gradually removed the embargo, and the manufacturer's business prospered.

The incandescent lighting system did not have such a stormy childhood as its older brother, but it had to struggle to live down the bad reputation of the early electric light family as a firebug. Quite a little effort was put forth by the electrical manufacturer and his friends and allies to correct the bad impression made by the early history of fires, and electrical salesmen were provided with elaborate statistics on fire losses due to the use of coal oil, etc. Special emphasis was laid on the safe character of electricity as an illuminant, and this campaign has continued to the present day.

The gas companies and oil companies are resisting every effort made to stigmatize their product as dangerous for fuel or light, but nevertheless, through the activity of the electrical inspector, electricity is the only artificial illuminant permitted in portions of the gas or oil plant. This has been possible through the progress of the art in meeting the demands of the rules and their enforcement in connection with lights in rooms containing explosive gases. The list of special devices for these equipments is increasing daily.

As you are doubtless aware, the early apparatus was almost entirely mounted on wood bases, and so-called "Underwriters' Wire" was the most common conductor used, helped out at times by soft rubber tubing where the wire passed through brick walls or wood floors. The early rules recognized wood-base devices for a number of years, and wood cleats for supporting conductors were considered safe for these early installations, and even bare wire was considered safe in engine rooms when supported on woodwork by means of metal straps. The great wonder is that so few fires were caused by these early plants, and the only explanation I can offer is that a very high quality of workmanship was employed on the installation work. There was always ample carrying capacity, the splices were carefully prepared and soldered as though for exhibition purposes, the joints in the wood moulding were fitted with cabinet-maker precision, the runs were straight and the turns square and the whole job was a work of art, mechanically. It was al-

ways a delight to inspect these old installations, and it took some courage to condemn them in view of the rather sloppy work that supplanted those old jobs. The product of the modern apparatus builder is a delight to behold as far as mechanical and electrical design is concerned, and it is as free from fire hazards as the present state of the art will permit, and all through it you will see the effect of the electrical inspector's effort to make the apparatus safe. No one is more glad to have this advice than the machine builder, because nothing will hurt him so much as apparatus that causes fires.

The manufacturer of electrical material and fittings has seen his business pass through the same metamorphosis as that of the machine builder. The early fittings caused fires.

The early switches and sockets were poorly designed and indifferently constructed till Underwriters' Laboratories began to apply the rules of the National Electrical Code to switch and socket construction, and during the early tests most of those on the market were found to be defective. Under this treatment wood bases began to disappear, the light soft metal contacts were eliminated and the slow, uncertain make and break soon gave place to a more certain action, and we now have as a result of this work the present line of enduring and efficient switches and sockets.

The first snap switch tested made a beautiful torch, and the manufacturer of it, instead of being provoked, was glad to have the defect brought out, thus enabling him to correct it. He early saw the value of rigid tests and rigid inspection, because it meant safety to his line of supplies and therefore to his business.

The first socket tested failed almost immediately, and the maker of it at once redesigned it to meet the tests, and it has done so ever since. Other manufacturers of sockets followed this good example, and the upward trend of the standard began.

The history of rubber-covered wire was somewhat different because the quality of this product went down before it came up. Thanks, however, to the persistence of inspectors and the co-operation of Underwriters' Laboratories with the Associated Manufacturers of Electrical Supplies, this material is now of uniformly good quality.

The fuse situation has been greatly improved. The first fuses were crude wood-based affairs, and they have now given place to the modern porcelain base Edison Plug Type fuse almost universally adopted for branch circuit protection and the Cartridge Enclosed Type for the protection of power equipments. The standardizing of the latter type was brought about by pressure from inspection departments, and the general use of the former type was quite largely promoted by inspectors, both through moral suasion and by ordinance enactment and adopted rules.

The early form of primary battery for electric bell work was not satisfactory, and many porters and engineers would connect the electric light circuit to the bell circuit. Neither the bells nor the wiring were suitable for this current, and many fires resulted. The refusal of the electrical inspector to permit this practice forced the consideration of specially designed bells, better wiring and the ultimate production of

motor generators for direct current signalling and the bell ringing transformer for alternating current systems.

Furniture manufacturers and others using glue were heating their glue pots with oil and gas. The night watchman or early morning porter started them so that by the time the men arrived the glue would be ready to use. The man who started these glue pots was not always careful to see that everything was ready before lighting the burners, and many early morning fires resulted. The application of the gas heater has been improved, and the introduction of the electric heater, with its signal lights and special circuit, which may be cut off at one point, has quite largely displaced the old oil and gas burners in the modern shops, and the fires have been reduced in number. When improperly designed or wired, even the electric glue heater becomes a serious hazard, and the inspector must see that only approved heaters are used and that they are properly installed.

The tailor shops gave the insurance inspectors much trouble at the time they were equipped with self-heated irons using gas and oil. The electrical inspector proposed the use of electric irons with signal lights to indicate the presence of current in the iron and helped the situation, and now even the laundries are quite generally equipped with them. The inspector has found it difficult to persuade the users of electric irons that irons not in use must be placed on stands designed for the purpose.

The history of the weather-proof socket is interesting. When the first incandescent lights were installed in the packing houses in Chicago, it was found necessary to wrap the brass-shell sockets with tape and paint or compound them heavily to make them moisture-proof. This was an expensive operation, and a cheaper socket for this work was sought. A glass socket was designed with the leading-in wires and exposed screw heads sealed in with a compound of litharge, sealing wax and powdered glass, but changes of temperature soon wrecked them. The second attempt brought forth a socket of moulded material which was a temporary help, but it did not please inspectors, and the weather-proof porcelain socket was produced and became popular. Later the inspectors, seeking safety to life, during the agitation of the grounding of secondaries, made a market for porcelain sockets, both key and keyless, for use in basements, bathrooms, and where exposed to corrosive vapors. The weather-proof porcelain socket held its own fairly well except when subjected to rough usage, and to meet this need the composition socket in various forms came into its own again. Of course, there was a need for these sockets, but the inspector must see the need and require the use of the safe and serviceable device or he will not be doing his duty.

The inspector has already done good work in bringing about the safety of utilization equipment, but much yet remains to be accomplished before even reasonable safety is assured. The inspector may do his full duty, and generally does, but he must have the co-operation of the public generally in handling the problem. The public must be made quite thoroughly acquainted with the proper way of using the various

electrically operated devices, and in this way their use will increase and the hazards diminish.

It might not be amiss in passing to call attention to the fact that rigid inspection in support of the test work at Underwriters' Laboratories and the progressive engineering on the part of the electrical manufacturers have produced a line of electrical materials, fittings and devices which are second to none in the world, and with these to work with the fires of electrical origin should be practically eliminated.

It has only been possible to touch a few of the high spots in pointing out specific instances of the services of inspectors in improving the quality of electrical fittings and material. This is all that is necessary in view of the broad experience each of you has had in this work. You are, no doubt, familiar with the standards, prepared by Underwriters' Laboratories in co-operation with the manufacturers, which provide for the inspection and test of the principal electrical materials and fittings at the factory. The product that is up to standard is labeled and periodically it is examined and tested in the field or samples are picked up in the open market and sent to the Laboratories for test. All of this work goes for naught unless the inspector avails himself of this helpful work and makes it of service to the public by restricting approval to those materials and fittings of known excellence. The manufacturers of electrical machinery and supplies are not slow in acknowledging the vital influence that the inspector of interior wiring exerts on the electrical manufacturing business. They see clearly that without inspection there is no standard, and without a standard there is confusion, and confusion strikes at the very foundation of everything it touches.

The Central Station Man's Estimate.

In the early days no one joined more enthusiastically with the old-time electrical contractor in fighting inspection under the National Electrical Code than did the old-time central station manager. He, too, thought he saw his business ruined by the establishment of a standard for wiring which produced reasonable safety from fire, but which, because of compliance with the standard, would cost a little more than the old sort, and he was sure than no one would ever want electricity if the wiring were to cost more. As the purchase of reliable material and fittings increased, the cost went down, and as wiremen became accustomed to the new methods of installation, they were able to do more work, and the cost finally dropped to a reasonable figure, and the business went right along as usual.

The improvements in lamps and generating machinery soon cut the cost of current per lamp till it supplanted gas and oil as possible competitors. The central station man gradually became aware of the many advantages which inspection brought him. As the old and defective wiring was gradually eliminated by inspection, his force of trouble-men decreased and the customers stopped "kicking" about the quality of the service. The cost of renewing sockets and switches was reduced to a minimum. The fuses seldom blew and the lights were seldom out. There were fewer complaints of excessive current bills due to current leakage, brought

about by defective material and careless workmanship, and last, but not least, the fires caused by faulty wiring became less and less, and the uneasiness of customers was gradually overcome by a low fire record.

The rigid enforcement of the requirements of the National Electrical Code has a most enthusiastic supporter in the progressive central station manager, and the better the quality of the inspection of interior wiring the better he likes it.

The inspector has helped the central station in another way. He has reported many cases of current theft, and has helped in many ways to eradicate this dangerous practice.

In a small city the electric light plant was shut down by some college boys who tampered with the wires. There was no inspector in the town, but the manager of the plant wished many times that there was one, if only to protect the service.

Sometimes the plant manager and the inspector "lock horns" over the outside wiring situation, but generally the inspector is right, and if he perseveres and secures the improvements needed there is no one so happy about it as the plant manager himself.

The central station man has given his estimate of the importance of inspection of interior wiring by employing inspectors himself, and these men look out for the company's interest as well as that of the prospective customer.

Conclusion.

"Let us hear the conclusion of the whole matter":

The business man may do his part in ordering that electric light wiring shall be installed in his building in full compliance with the National Electrical Code, and the householder may order that the wiring in his home shall comply with the National Electrical Code; the electrical manufacturer may be ever so careful in the production of suitable material and fittings; the electrical contractor may be particular about instructing his men as to the way in which the work must be done; and the central station man may have his part of the work well in hand; but it remains for the inspector of interior wiring to see to it that suitable material and fittings are properly used, and that the contractor's men employ good workmanship while installing the work, and that the central station employees make a proper connection to the installation. A failure anywhere along the line may render the whole job useless.

The inspector of interior wiring is the keystone of the arch of the electrical industry, and if he fails to properly perform his duty, or if there is no one to perform such duty, the industry in that locality is in grave danger of collapse because it ceases to have a foundation of safety.

The inspector of interior wiring wields a sharp, two-edged sword, and he has handled it with dexterity in most cases, for he is the most popular city official, excepting in some cases the fire chief. He has gained this popularity through serving the public, and in serving the public faithfully he has hurt no one, but has helped all. Heretofore, but one edge of the sword has been used—that which produced safety to property. He is now to be called upon to use the other edge—that

which produces safety to life. Will he do as well with the latter as he has done with the former? There is no question but that he will.

The importance to the public of inspection of interior wiring is beyond computation, and while we have touched upon some of the advantages, many more of them have had of necessity to be omitted for want of the requisite time to present them.

Members of the International Association of Municipal Electricians! Do you realize the importance to the public of inspection of interior wiring? I think you do, or I would not be here today to review one or two phases of the subject with you. I would have you take courage and know that the importance of your work is being gradually appreciated, and will ultimately be properly rewarded. It requires patience. Don't let yourselves be discouraged, and render the public defective service, because it is sure to react upon you sooner or later, and then you lose the satisfaction which comes of work well done.

The "Clean Up and Paint Up" Twins

LADIES AND GENTLEMEN, ALLOW ME TO INTRODUCE TO YOU THE "UP" TWINS MISS "CLEAN UP" AND MASTER "PAINT UP". THEY WILL MAKE OURTOWN A BETTER —HOME TOWN— ALL JOIN IN THE CHORUS
MISS SPRING
CLEAN UP
PAINT UP
PAINT

—News-Bee

Fan blades which probably caused fire in an Oregon flour mill.

Loose Fan Hazard in Flour Mills.

By Allen G. Tindolph
(Member N. F. P. A.)

The accompanying photograph showing fan blades was taken after a fire that started in the frame housing of an air suction fan installed in the basement of an Oregon flour mill, to handle the dust collection and exhaust from certain grain elevators and small hoppered receiving bins. The fire was discovered promptly, and the loss was confined to the fan and certain portions of the wind trunking, all of wood construction. Serious loss could have occurred, however, had the fire been given time to spread through the wind trunking into the mill proper.

Some question arose as to the cause of the fire. Seemingly a great deal of the evidence had been destroyed, but upon close examination the writer found the four fan blades in the debris, and they seemed to furnish the evidence desired. It will be observed from the photograph that all the blades are curled in about the same manner, excepting the upper one, which seems to have been badly curled. Although the picture does not show it plainly, the little screw holes in the blades were all quite ragged, giving evidence that the screw heads had been forcibly pulled through the screw holes in the blades. Severe scars or scratches also were in evidence on all the blades. The fan frame upon which these blades were originally attached was somewhat sprung in places and some of the corners were bright.

As no trouble had been experienced with hot boxes, it is the writer's opinion that the fire was caused in the following manner: One of the

fan blades had become loose, possibly a screw had fallen off, allowing the blade to engage the fan housing, and thereby become forcibly detached from its support. This accident contributed to the forcible detachment of the other three blades, as the fan continued to operate. During this disturbance there was probably considerable sparking within the fan housing, affording ignition to inflammable dust entering the fan, and thus starting the fire.

The fan was 36 inches in diameter and the blades about 11 inches in width.

The writer has always cautioned millers to examine periodically their air suction fans in order that they may be sure that all the blades are fastened securely to the fan frame. In the present instance, it is quite apparent that the blades were not curled by heat, and they must have experienced severe friction and juggling within the fan housing to have emerged in the condition in which they were found.

Prohibition of Wooden Shingles.

The following tabulation of cities in the United States prohibiting the use of wooden shingles within their corporate limits, prepared by the Committee on Construction of Buildings of the National Board of Fire Underwriters, is the result of a long and painstaking investigation. It is correct so far as scrupulous care could make it so. It is not unlikely, however, that it contains both "errors of omission and commission." The Committee would welcome any suggestions which will add to the reliability of the data. Except where otherwise indicated, it may be assumed that the entire city is covered by the prohibition.

	Date of Adoption	Percentage of Repairs Permitted		No. of Repairs in One Year	Date for Entire Removal of Existing Roofs
		Ordinary	Fire		
Alabama.					
Florence	May 1, 1916	20	20	1	
Huntsville	April 18, 1916	25	25	1	
Montgomery	Mar. 2, 1916	25	25	1	
Sheffield	May 8, 1914	25	25	1	
Florida.					
Bradentown	June 30, 1917	25	25	1	
Daytona	Sept. 26, 1917	10	20	1	Within 12 Years
Fernandina	Aug. 15, 1917	10	20		Within 12 Years
Jacksonville	July 6, 1901	25	25	1	
Lakeland	May 27, 1917	25	25	1	
Ocala	July 6, 1917	10	20	1	Within 12 Years
Orlando	May 29, 1917	10	10	1	
Sanford	Dec. 3, 1917	10	20		Within 12 Years
So. Jacksonville	Dec. 1, 1909				
St. Augustine	Aug. 1, 1917	10	20	1	Within 12 Years
St. Petersburg	Nov. 22, 1916	25	25	1	
Tallahassee	July 27, 1917	10	20	1	Within 12 Years
Tampa	Aug. 20, 1911	25	33	1	
West Tampa	Dec. 28, 1916	10	10	1	

Georgia.

	Date of Adoption	Percentage of Repairs Permitted		No. of Repairs in One Year	Date for Entire Removal of Existing Roofs
		Ordinary	Fire		
Atlanta	June 6, 1917	10	20	1	1930
Augusta	April 2, 1916	25	25	1	
Brunswick	Sept. 24, 1917	10	20		Within 12 Years
Columbus	Jan. 1, 1916	20	20	1	
Decatur	Jan. 1, 1918	10	20		Within 12 Years
Dublin	April 17, 1918	10	20		Within 12 Years
Hawkinsville	Sept. 3, 1917	10	20		Within 12 Years
Kirkwood	Aug. 7, 1917	10	50		Within 12 Years
Macon	Aug. 29, 1917	10	20	1	Within 12 Years
Manchester	Sept. 3, 1917	10	20		Within 12 Years
Savannah*	July 1, 1908				
Tifton	Feb. 26, 1917	25	25	1	
Valdosta	Sept. 5, 1917	10	20	1	Within 12 Years
West Point	Sept. 10, 1917	25	25	1	

* Prohibited from entire city for years, though not a city statute except in fire limits.

Illinois.

Springfield	Oct. 29, 1917	10	20	1	Within 12 Years

Iowa.

Davenport¶	July 1, 1917	40	40		

¶ Wood shingles treated with fire-retardant are accepted.

Louisiana.

Baton Rouge	July 10, 1917	10	25	1	
Donaldsonville	May 1, 1914				
Napoleonville	May 2, 1911				
New Orleans‡	Aug. 2, 1910				
Shreveport*	1916	10	10		

* A and B fire limits.

‡ Shingles prohibited from parts of city since 1790. Practically no shingles in corporate limits.

Massachusetts.

Boston	Oct. 6, 1914	No replacement with wooden shingles permitted			
Brookline	Mar. 31, 1903	100	100		
Cambridge	Feb. 7, 1913	100	100		
Chelsea	1916	100	100		
Fall River†	July 1, 1915	None since Jan. 1, 1917			Jan. 1, 1930
Lawrence	Jan. 1, 1915	Only minor repairs permitted to stop a leak			
Lexington**	Mar. 9, 1914	100	100		
Lynn	1916	No specified limit P actice is to permit smallest possible amount.			
Medford	Mar. 9, 1915	Repairs permitted if building is not altered in height			
New Bedford	Jan. 1, 1917	25	25		Jan. 1, 1930
Newton	Jan. 1, 1915	Patching or minor repairs permitted on shingle roofs			
Salem	Nov. 1914	None			
Somerville	Sept. 25, 1916	25	25	2	

† First and second fire districts (large part of city.)

** Shingles permitted on buildings located on lots exceeding one acre in area.

Mississippi.

	Date of Adoption	Percentage of Repairs Permitted		No. of Repairs in One Year	Date for Entire Removal of Existing Roofs
		Ordinary	Fire		
Jackson	June 8, 1918	25	25		Within 10 Years
Meridian	Mar. 27, 1917	50	50		No building to be covered with combustible material or shingles after June 1, 1917.
Vicksburg	Sept. 3, 1917	20	20	1	Within 12 Years

New Jersey.

Atlantic City	Aug. 24, 1909	33⅓	33⅓		
		Only one repair permitted to same roof			
Hawthorne	June, 1916	25	25		
Hoboken	*	As permitted by Building Inspector			
Newark	1911	50	50	1	
		25	25		
Paterson	July 21, 1913	Repairs made at discretion of the Building Inspector			
Perth Amboy	Jan. 1, 1916	Repairs allowed only when roof lines are not changed			
Trenton	1907	25	25		

* Date of ordinance not obtainable. Stated more than 20 years old.

New York.

Albany	Dec. 4, 1911	1 shingle per sq. ft. of roof surface.			
Solvay	June 23, 1914	25	25		

North Carolina.

Asheville†	Nov. 1, 1917	10	20	1	Within 12 Years
Durham	Oct. 1, 1918	10	20		Within 12 Years
Raleigh	July 1, 1918	10	20		Within 12 Years
Winston-Salem	July 1, 1918	10	20		Within 12 Years

† Building inspector has power to remove any roof excessively inflammable.

Pennsylvania.

Allentown	Mar. 8, 1908	No limit if height is unaltered			
Easton	Dec. 17, 1915	50	50		
Hanover (Boro of York)	Mar. 3, 1916				
Reading	Jan. 2, 1892	50	50		

South Carolina.

Charleston	June 1, 1838	None since 1862			
Columbia	——	33	33	¶3	
Darlington	Sept. 3, 1917	10	20		Within 12 Years

¶ No more than 3 repair permits issued on the same roof.

Tennessee.

Chattanooga	Oct. 1, 1917	10	20	1	Within 12 Years
Jackson*	1916	50	50		
Knoxville†	March, 1915	20	20		
Memphis**	Dec. 1912	10	10		
		Inner zone 50% repairs permitted in Middle Zone. No restriction in Outer Zone.			
Nashville¶¶	June 7, 1916	30	30		

* 67 per cent.
† Knoxville 75 per cent of built-up area.
** 68 per cent.
¶¶ New shingle roofs may be put on residences or outhouses in the Third Zone.

Texas.

	Date of Adoption	Percentage of Repairs Permitted		No. of Repairs in One Year	Date for Entire Removal of Existing Roofs
		Ordinary	Fire		
Dallas	April 29, 1918	40	40		Within 10 Years
El Paso	April 12, 1917	25	25	1	
Galveston	Oct. 29, 1914	25% of cost of new roof		1	
Paris	1916	25% of cost of new roof			§
San Antonio††	Jan. 13, 1913	25% of cost of new roof			

†† A, B and C Districts (major portion of city.)
§ Will not issue repair permit if one has been issued before.

Virginia.

Buena Vista	Oct. 12, 1917	20	20	Within 12 Years
Martinsville	Sept. 11, 1917	10	20	
Norfolk	Nov. 23, 1912			
Richmond	July 25, 1908	No limit provided building is not altered in height		
Suffolk	June 20, 1916			
Warrentown	July 12, 1917			

Total number of cities—91

Maintaining Water Supplies in Yard Mains.

By Geo. H. Greenfield,

(Member N. F. P. A.)

It is frequently found, when making changes or repairs on the fire main systems of large industrial plants, that the amount of protection removed while the water remains shut off is excessive and creates a considerable hazard. This condition can often be improved by installing sufficient sectional control valves, but even then, in large plants, outlying portions of the fire mains are frequently rendered useless when section control valves are shut to allow of repairs, etc.

A system that has recently been adopted by a corporation owning several large plants is as follows:

Double female hose couplings have been provided at the different works, and, before any section is shut off, the fire main plan is carefully examined by the fire chief. In a great many cases it is found possible to bridge a section of water main that is out of service, or to join up an outlying section by running lines of hose from hydrant to hydrant, using the double female couplings.

In summer the water is turned on, but in cold weather the lines of hose are run and all made ready, but water is not turned on.

During a recent shut-off one Sunday to allow of some extensions on the fire loop at one of the works, the adoption of the above system made it possible for water to be maintained on the lumber yard section, which included five hydrants and three large sprinklered lumber storage buildings. Under normal conditions the protection would have been entirely removed whilst the changes were being made.

A few six-, eight- and ten-inch soft taper wooden plugs about 2 feet long are kept in the fire station so that when mains are being cut they can be plugged in a hurry should occasion arise.

The double female hose couplings also serve the additional purpose of allowing municipal fire department steamers to couple up to the yard hydrants and boost the pressure should this be necessary through failure of the plant fire pumps, or through excessive demand for water. In the latter event, the system serves a purpose similar to that of the reverse hydrant mentioned by Mr. Charles E. Worthington in the July, 1918, issue of the QUARTERLY ("Planning Factory Water Supplies for Emergencies," page 76).

Collapse of Molasses Tank, Boston, Mass.

January 15, 1919.

Special Report by Gorham Dana, Manager, Underwriters' Bureau of New England.
(Member N. F. P. A.)

[Special interest attaches to this report because of the wide currency which has been given to the statement that the collapse of the tank was caused by an explosion of gases of fermentation.]

On Wednesday, January 15, 1919, at about noon, a large molasses tank located in a lot just off Commercial Street, Boston, collapsed, causing a loss of life of nineteen persons and a heavy property loss. The tank was owned by the Industrial Alcohol Company, and the molasses was used at their plant in Cambridge.

Construction.

The tank was a cylindrical steel structure erected in 1915 on a concrete foundation. It was 90 feet in diameter and 50 feet in height at upper edge of the shell. It had a capacity of 2,378,000 gallons. The shell was made up of steel plates, there being seven vertical sections of thicknesses varying from $\frac{5}{16}$-inch to $\frac{11}{16}$-inch. The horizontal joints were lap, single riveted. The vertical joints were lap, double and triple riveted, with the exception of the lowest section, where the joints were butt, double strapped. No interior bracing of the shell was considered necessary. The top was cone-shaped, with a 5-foot rise to the center, and was made of $\frac{1}{8}$-inch steel and supported by a central latticed column with surrounding vertical I-beams and channels connected and braced by a system of tie-rods. At the apex of the top was a 6-inch gooseneck

vent pipe, and near the shell were four 20-inch manholes with hinged covers without fastenings. The bottom of the tank was also of steel plates, ⅜-inch in thickness, with single riveted lap joints. Where the top and bottom connected with the shell they were single riveted, as was the shell at these points. The angles used at the top were 3 x 3 x ⅜-inch. Those used at the bottom were 4 x 4 x ¾-inch. There were three pipe connections to the tank, one 14-inch intake through the bottom near the shell, one 10-inch draw-off through the second section of the shell 13 feet from the bottom of the tank, and a second 14-inch intake through the bottom, put in for emergency only and never used. There was also a 24-inch manhole in the lowest section of the shell near the bottom joint. This manhole gave access to the tank when empty, and was seldom used.

On the day of the accident the tank was practically full, and it gave way with a rumbling noise resembling a light explosion. The tank sides sheared vertically at two points and tore away from the top and bottom plates. These two pieces, 50 feet high and approximately 170 and 100 feet in length, were carried by the flood of molasses to a considerable distance. The larger piece was carried out into Commercial Street, where it came in contact with the Boston Elevated Railway structure. It smashed one steel supporting column and was held by two other columns beyond. The Elevated structure was damaged to the extent of many thousand dollars, and traffic over it was stopped for several weeks. The smaller piece was carried in the opposite direction, taking the top of the tank a short distance with it. Several small wooden buildings near the tank were completely wrecked. The molasses flooded the vicinity for a distance of several hundred feet in every direction and filled up many cellars.

The Fire Department was called out to rescue persons from the wreck and to help clean up the debris. Hose streams and open hydrant butts were used to flush the streets, and practically no molasses was saved.

The loss of life occurred largely in small buildings near the tank and amongst persons passing by in the street.

Chief Justice Bolster of the Municipal Court has filed a report of the inquest of the disaster, which reads in part as follows:

"Through the efficient co-operation of the police of Station 1, much of the shell surrounding critical points has been reassembled and has furnished opportunity for reliable tests, which the courtesy of the officials of the Charlestown Navy Yard have enabled me to have made in their metallurgical department. Before stating the results of those tests, it may be well to refer to the possible causes to which this disaster may be ascribed.

(1) Vibration. This could come in any substantial measure only from the pressure of elevated trains, and it is stated that one passed shortly before the tank burst. But the elevated system antedated the tank. This was a known factor to be allowed for in the factor of safety.

(2) External Violence. The evidence gives no suggestion of this except in the impact, on at least two occasions, of cars which split the switch lying southeast of the tank.

(3) Explosion. There is no evidence of this in the sense of sudden and violent disruption from ignition of contained gases. There is no plausible source of such occurrence.

Molasses will generate by fermentation a very considerable amount of carbon-dioxide gas, over 200 times its own volume. While this would ordinarily escape through the gooseneck in the top, it is likely the large mass of colder, viscous molasses, which was in the tank before the January fill, may have acted as a tamping agent to confine some of the gases generated in the warmer layer pumped in from the bottom, causing enough additional pressure to furnish the proverbial last straw, which seems to me the most plausible explanation of the fact that the tank stood up for forty-eight hours after the completion of its last filling. For this molasses was evidently in process of fermentation.

Even, however, assuming the liquid charged with this gas to the point of saturation, on the lower strata, the comparative ease of its escape to the top seems to negative the idea that such conditions could have burst the tank, given a proper container.

My conclusion from all this evidence is that this tank was wholly insufficient in point of structural strength to handle its load, insufficient to meet either legal or engineering requirements.

I am satisfied that the adequate and predominating cause of this accident was a bursting from internal pressure exceeding its structural strength, and I so find.

This structure being maintained in violation of the law, the lessee has incurred the penalty which is absolute, not dependent of knowledge or intent. I have therefore ordered process against the United States Industrial Alcohol Company. If the Hammond Iron Works could be reached by process I should take the same course as to it. If the outcome of the process now begun be a determination that the building law does not embrace such structures, the law should be amended to include them, for they are clearly capable of the mischief contemplated by the statute."

The following comments furnished by Mr. Charles W. Haskell, of the Great Western Sugar Company, (Member N. F. P. A.) are also of interest:

Notes on Molasses Tank Failure.

The tank was evidently only figured on a water basis of 62½ lbs. per cubic foot of contents, instead of 90 lbs. per cubic foot for weight of molasses. The plates making up the tank are heavy enough for the lighter loading only, with practically no factor of safety.

Figured on a molasses basis, the three lower rings of plates are stressed above the maximum ultimate stress allowed for boiler steel, which it is assumed was used. The figures we obtained resulted from the figured molasses load only, and did not include additional stresses from the weight of the plates themselves or possible further additional stresses due to bulging, or tank sides being out of plumb. Either condition could give a large increase of tensile stress.

The description of the tank at hand indicates poor detail at point where the bottom plates join side plates. Special treatment at this point is required to care for the pressure tending to separate plate sides from the bottom angle.

The stresses found are far in excess of the ultimate breaking stress of the metal, and would be further aggravated due to the joints having an efficiency of only 57 per cent for the single riveted lap joints with ⅜-inch plates, to 75 per cent for the triple riveted lap joints with ⅝-inch plates. These last-mentioned plates composed the ring next to the bottom. The bottom ring of 1⅛-inch plates had vertical joints double butt strap riveted. If this joint was properly made it would have an efficiency of 90 per cent, but the attachment of plates to the bottom 4 x 4 x ¾-inch angle would not develop nearly this efficiency.

With a load, from contents only, of 27,600,000 lbs., or 4,300 lbs. per square foot, or 5,000 lbs. per square foot total, including weight of tank, and single riveted lap joints in the bottom ⅜-inch plates, the concrete foundation without a thick sand cushion is not good.

Special note is made of the vent on the top of tank, which is usual in oil and light grain tanks and water tanks with tight covers, both of steel and concrete construction.

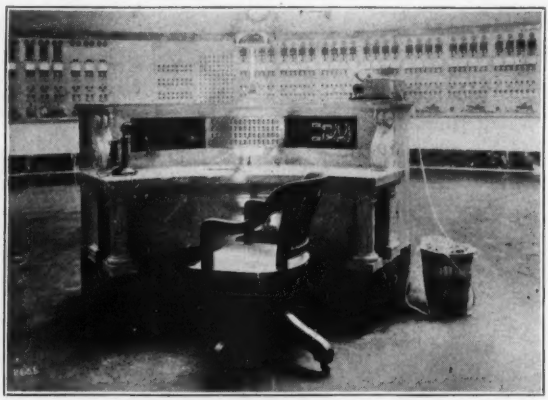


Fig. 2. Central portion of main operating board with chief operator's desk in foreground.

Central Fire Alarm Station of San Francisco.

Courtesy Electrical Review

The central fire-alarm system of San Francisco, Cal., is not only housed in an unusual building but possesses many unusual and novel features. The lesson of the disastrous conflagration that practically wiped out the city in 1906 was that every effort must be made in fire prevention to eliminate any possibility of the occurrence of another such catastrophe. This explains many of the unique features of the station.

The building is of reinforced concrete and is fire-resistive, earthquakeproof, mobproof and burglarproof. In order to eliminate all fire hazard by communication from outside sources, the building is located in Jefferson Square, a small public park, and no buildings are permitted to be constructed within 400 feet.

Architecturally, the building is very pleasing and an ornament to the park. It has but one story and basement and is about 65 feet square. The main operating room occupies almost the entire first floor with the exception of a small private office, a small room occupied by the telephone operator, a kitchen and lavatory.

There are no windows leading into the main operating room, all daylight coming from the skylight seen in the general view (see *Frontispiece*). This skylight is double, the lower one forming a large attractive panel in the middle of the ceiling. All skylight framework is of steel and sheet metal, and all glass in the skylight is of heavy wired type. Ventilation is provided by louvers extending entirely around the skylight. The surrounding roof is of red tile. The exterior of the building is finished with cement plaster applied by the "cement gun" pro-

cess. The entire station presents a most pleasing appearance, being beautifully ornamented on all sides with flowers and shrubbery. The entrance is lighted by two electric lamps mounted on ornamental iron posts.

Incoming Tables and Terminal Rack.

All cables from the 820 alarm boxes terminate at a point in the plaza on the east side of the building, and on Turk street immediately in front of the entrance. There are two manholes at each of these points. From these two points the cables lead to the terminal rack, which is centrally located in the basement. From the terminal rack the cables are distributed to the main operating board.

The cables from the various alarm boxes are carried to the station in conduits of the telephone companies, the high-pressure piping system ducts and the ducts of the Department of Electricity. The cables carried in the high-pressure ducts were installed in the same trenches and at the same time as the high-pressure water pipes. These ducts were of creosoted wood, 4½ inches square, with 1½-inch creosoted cover planks.

The terminal rack in the basement of the station is mounted directly over the cable pit. There are three runways for the distribution of the wires from the rack to the main board. These runways consist of troughs of angle iron and wire screen.

Main Operating Board.

The main operating switchboard seen in the back of Fig. 2 comprises 41 panels, is semicircular in form, 102 feet in length, and divided into three sections. The wires are distributed to these three sections by the three runways referred to, each runway supplying one section. The operator's desk seen in the foreground of the illustration, is centrally located so that every instrument on the main operating board is always within his vision.

All instruments on the switchboard, with the exception of the registers and meters, were constructed in the shops of the Department of Electricity. The switchboard is now equipped with 48 box or signal circuits (there being four to each panel). Not all the switchboard panels are equipped at the present time; there are 9 additional panels to be equipped with additional box or signal circuits as extra circuits become necessary.

Box or signal circuits occupy that space on the switchboard (see Fig. 2) extending from the clock toward the right, 7 panels being shown in this view. To the left can be seen some of the panels carrying the so-called "hospital" circuits. To the right of the hospital circuits can be seen a panel which is yet to be equipped with 3 hospital circuits, which will be added as necessity arises. There are now 5 panels devoted to the hospital circuits, these circuits taking care of other lines in case of trouble, such as open lines, grounded lines, and lines crossed with outside circuits. When any of the signal circuits, joker circuits, or tapper circuits are out of order, they are switched over to the hospital circuits, which are supplied with the necessary current from a motor-generator set, one such machine being supplied for the 3 hospital circuits on each panel. Fig. 3 shows a near view of part of the hospital panels. The motor-generators are mounted on a slate panel back of the main switch-

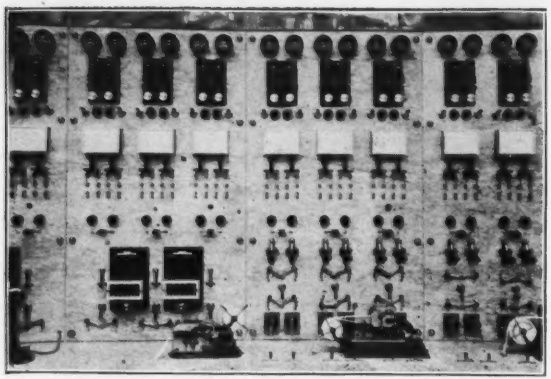


Fig. 3. Portion of main board showing "hospital" panels.

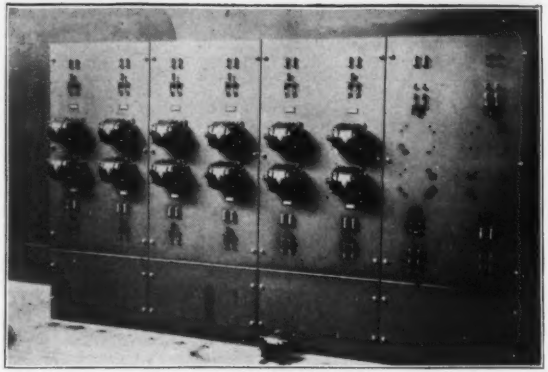


Fig. 4. Motor generators for the signal circuits—slate panels back of main board.

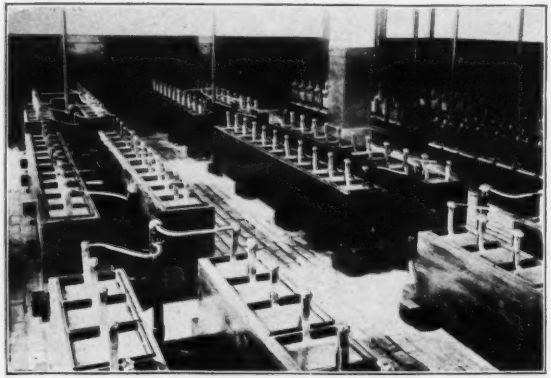


Fig. 5. Storage batteries in separate room in basement of station.

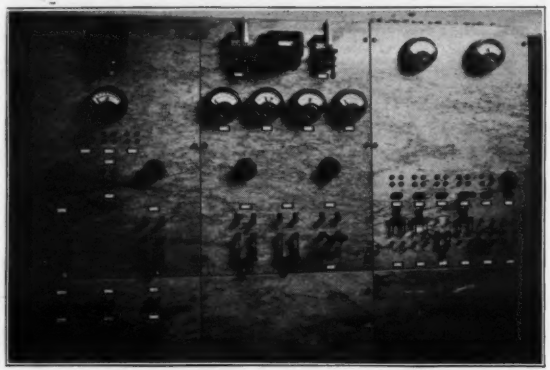


Fig. 6. Charging panels located back of main switchboard.

board and are shown in Fig. 4. They are of General Electric make, operating on 120 volts.

In Fig. 2 immediately to the right of the vacant hospital panel can be seen two terminal panels, one for handling the signal lines and one for handling tapper and joker lines when any of these lines are to be transferred to the hospital circuits. These terminal panels are provided with jacks, cords and plugs for plugging in when connections are to be made. The jacks are connected with the line terminals, and the cords and plugs all connected with the hospital panels.

By means of these transfer connections and the hospital equipment the grounded or crossed lines can be entirely isolated and connected to a panel provided with special equipment for testing and treatment of crippled lines.

The hospital circuits and the terminal panels are capable of taking care of 3 tapper and 3 joker and 6 signal circuits at one time, which is usually sufficient to take care of all lines that are out of order. Most of the trouble in San Francisco is caused by wind storms, there being no ice, snow, or similar conditions to contend with.

When it is desired to connect a line with the hospital line, the line switch is thrown for a terminal panel connection, then the hospital panel is connected by using the plug and jack.

There are three panels on the left of the main switchboard devoted to tapper signal circuits (there being 10 circuits now in operation with room for additional installations in the future), and three panels devoted to joker signal circuits of which there are 10 now in operation, with room for additional installations.

At 8 o'clock in the morning, 12 noon, and 6 o'clock in the evening, 3 blows are struck on the joker and tapper circuits merely as a time test. The joker circuits are available for handling not only the alarms of fire as an auxiliary, but also all other calls, such as special calls for high pressure, extra engines, trucks, and other apparatus, in and out of service, etc; their principal use, in fact, is for such departmental calls.

The motor-generators for the tapper and joker test sets are mounted on a horizontal slate panel, located back of the main switchboard. The tapper and joker generators are of the Holtzer-Cabot type and operate on 115 volts.

In the construction of the main switchboard, Vermont electric blue marble was used for the switch panels and shelves for the registers. These shelves are 1¼ inches thick, 18 inches deep by 30 inches wide. The panels are 1 inch thick, 30 inches wide by 4½ feet high. The entire board is capped with yellow Sienna marble. The facing is of white statuary marble and the base is finished in verde antique, this combination producing a very pleasing and harmonizing effect.

The iron frame supporting the switchboard is cemented into the concrete floor, making it absolutely rigid, and the semi-circular form of the board makes it self-sustaining. Access is had to the space back of the board by means of steel doors. Here there are connections for portable lamps and for electric soldering irons, rendering it very handy to make repairs.

The entire floor of the main operating room is covered with a very heavy linoleum, which permits quiet and comfortable walking without

stirring up dust. The main operating room is well lighted at night by a semi-indirect lighting system with ornamental bowls. A switch is provided by means of which an emergency lighting circuit on the ceiling can be operated from the storage batteries.

Storage Batteries and Charging Facilities.

The source of power for operating the circuits on the main switchboard is a duplicate storage battery of 280 ampere-hour capacity installed in a well ventilated acidproof room in the basement, see Fig. 5. There are two sets of batteries, one set being held in reserve. The battery drives dynamotors, through which power is furnished to the various circuits. Each dynamotor supplies current for four circuits. This arrangement was made for the purpose of more thoroughly insulating the lines from each other and also the battery from the ground.

The batteries can be charged from the direct-current mains or the alternating-current mains of the two different power companies. Three panels located back of the main switchboard (see Fig. 6) are devoted to the supply current distribution and the charging of the batteries. Most charging is done by floating the idle battery on the direct-current mains, the other battery working the station circuits in the meantime. A motor-generator is used for charging from the alternating-current source.

For use in case of emergency, a Fairbanks-Morse 20-hp. gasoline-engine-driven generator (Fig. 7) has been installed, for supplying current to the battery and lights for the building. Large storage capacity for fuel and water will enable this equipment to operate for a long period, without being furnished with additional supplies. In order to eliminate any fire hazard from the gasoline engine, it is separated from the rest of the basement by a 10-inch reinforced concrete wall.

General Scheme of Operating.

All alarms from street boxes are received at the central fire-alarm station on telegraph sounders and registers. These can be seen in Figs. 2 and 3. The street fire-alarm boxes are arranged to sound in their numbers four times. After two rounds are sounded, the box number is checked on a list by the operator at the board, and instantly the operator at the desk calls out the number as he hears it. The operator at the board checks and repeats the number. Immediately the operator at the desk, whose duty it is to send the alarm to the engine houses, sends out the alarm twice over the tapper circuit and twice over the joker circuit, and all fire houses that respond to that number immediately go to the fire.

When the battalion chief reaches the fire, he, or his assistant, calls the central fire-alarm office by means of a regular telegraph service key and sounder, which are located in each fire-alarm box. The battalion chief calls for additional engines, chemical wagons, the high-pressure service, etc., by sending in to the central fire-alarm office the code telegraph signal that will provide him with whatever is required, and the operator at the central office orders out the engines or chemical wagons, or notifies the high-pressure station, which ever may be the case, by sending the proper signal on the joker lines.

On arrival at the street box the battalion chief puts the fire-alarm apparatus in service again. The boxes are equipped with clock mechan-

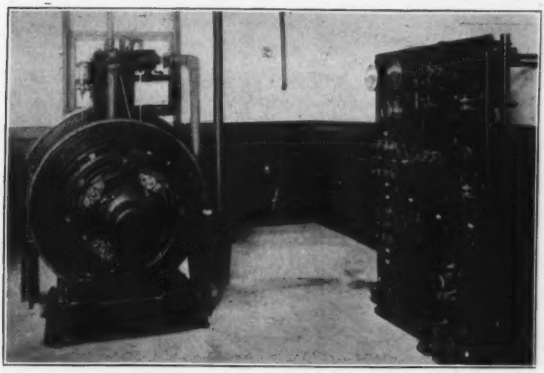


Fig. 7. Special charging generator connected to gasolene engine — at right is control panel for same, also for motor-generator charging set in other part of basement.

ism and a character wheel, and by pulling the hook, the mechanism is released, and the character wheel that sends in the alarm revolves four times before stopping. The box system works on a closed circuit and the character wheel in rotating breaks the line circuit, thus operating a relay in the fire-alarm office, which in turn operates the local circuit. There are 48 incoming circuits, and the smallest number of fire-alarm boxes on any one circuit is 4, while the largest number is 40, but the average number is 20.

The box number is shown on an illuminated box list. This list is illuminated only when an alarm is coming in. This box list is removable, and is transferred to the hospital set when the corresponding circuit is to be switched to the hospital set. A pilot light is placed just above this box list, which operates in unison with the register, flashing the same code, and calling attention of the operator in case he should fail to hear the sounder.

Each fire-alarm box is pulled regularly once a month for a test, at which time it is rewound. Boxes can send in 15 or 16 alarms, without requiring rewinding. All boxes are rewound as soon as they have been pulled 3 or 4 times.

There are two electric clocks in the station, one located on the main switchboard, and the other on the operator's desk. Both clocks work together, being regulated from the master clock in the Ferry Building. The station is equipped with two Weston station voltmeters for testing the lines.

At the desk there is a telephone connected with all fire houses, pump stations, and other departments of the Fire Department. The telephone is connected with these departments through a switchboard located in the building, manned by a special operator at all hours. Immediately to the right of the telephone, in Fig. 2, there is a power switch for controlling the current for operating the office. This enables connection to

be made from either outside source or battery. This switch controls the current for operating outgoing signals and the combination permits the connection with the service of the outside direct current or the battery service within the building, also the current from the motor-generator set operated by either of these two services. By means of the two striking keys seen at the extreme right of the desk and the jack and plugs seen in the center of the desk, the operator can make connections, and handle all signals from this desk when necessary, but usually the signals are handled by the operator at the main switchboard, and the desk operator handles the signals in this manner only when the operator at the board is very busy. The main striking key for sending out all outgoing signal alarms can be seen on the desk a few inches to the right of the two plugs. All signals sent out are recorded on the two registers attached to the top of the desk.

There are 6 crossing signals in two circuits on Market street, the city's principal street, which are used in case an alarm is turned in from that particular neighborhood, or from a neighborhood which will require the apparatus to cross Market street, or make a run up or down Market street.

The warning bells are mounted on the lighting poles, and are operated by remote control, handled by a switch in the central fire-alarm office. The bells continue to ring for a length of time required for all the fire apparatus to either cross Market street, or to make the run up or down the street, as the case may be. On all first alarms, the bells sound for 3 minutes, for second alarms 4 minutes, third alarms 6 minutes, and fourth alarms 8 minutes.

When these bells sound all traffic clears the streets. All pedestrians remain on the sidewalks, and the traffic officers or other policemen see that all vehicles are in such a position as to give the coming fire apparatus the right-of-way.

An alarm bell is also located at the Third and at the Fourth street bridges, to warn the bridge tender in case any fire apparatus intends using the bridge; when this bell sounds, the bridge, if in raised position, is lowered as soon as possible, and if it is down, it is not raised until all the fire apparatus has passed.

The central office has been in service over three years with completely satisfactory results. The entire San Francisco fire-alarm system is probably the most complete and most thoroughly safeguarded that has ever been installed. It therefore continues to be a model for other cities.

Leather Dyes, Stains and Finishes.

By F. T. Gilbert,

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The materials discussed in this paper are found principally in three classes of industrial plants, namely, Blacking and Stain Factories, Tanneries, and Shoe Factories.

In considering the materials, the viewpoint taken is that of the fire insurance engineer or underwriter, and for this reason the purely technical features of the chemical processes involved are avoided, except in so far as an understanding of the reactions is necessary to the proper appreciation of the hazards of fire which may be present.

While the hazards incident to the composition and use of the substances discussed may be appreciated by those in charge of the plant where they are prepared, it is apparent that these hazards are not always understood by those handling these materials in industrial plants, and consequently the proper precautions necessary to safety from fire are frequently not provided. No attempt has been made to formulate specific rules for the safeguarding of the hazards, but the thought is rather that if the nature of the hazards is properly understood the proper precautions may be provided.

Brief History of Colors and Dyes Used.

Before the development of the coal tar dyes, natural dyes were used in the leather trade, such as logwood, elderberry juice, Persian berries, hypenic, quercitron, fustic, etc. Some of these dyes are still in use. Similarly dressings and shoe pastes were made with natural dyes. The coal tar dyes have now largely replaced these. The coal tar dye industry was discovered in England, but was developed principally in Germany, and in 1912 there were 921 distinct dyes on the market, divided into 17 separate chemical classes. The number of varying shades, produced by different combination of these dyes, runs into many thousands.

In leather dyeing coal tar colors have largely superseded the natural dyestuffs. It is needless to say that these colors are not in any ordinary sense "extracted" from coal tar, but are chemical derivatives and compounds mainly from three hydrocarbons, benzene, naphthalene and anthracene. In general it may be said that aniline and phenol dyes are derivatives of benzene and its homologues; and naphthazarin is a corresponding naphthalene derivative; but the color molecules are extremely complex, and types are not susceptible of any simple classification on these lines.

They may, however, be classified according to their behavior with some of the more general reagents. Prof. Green (Journal Soc. Chem.

Ind., 1893, page 3) has grouped those which are most likely to be used for leather into those which are soluble in water and those which are insoluble; dividing the soluble again into basic colors which are precipitated and acid colors which are not precipitated by tannin solutions, with still further sub-divisions.

In another, Rota's, scheme of analysis, the first classification is into dyestuffs reducible, and secondly, dyestuffs not reducible with stannous chloride and water.

The cause of color by dyes of any type is not easily determined, but certain groups and arrangements of atoms which probably result in a strained or unstable equilibrium seem to have a bearing on it. Another theory is connected with the action of light whereby certain molecules vibrate in unison with light waves and others do not, thus reflecting or absorbing color.

I.

Manufacture of Blacking, Stains and Finishes.

General Manufacturing Processes.

These vary with the nature of the material used. Water colors are prepared by grinding in paint mills. Aniline colors (coal tar dyes) are usually prepared by mixing and boiling in steam-heated kettles. Pyroxylin finishes require compounding, thinning and stirring.

Curriers' Finishes.

Colors: Raw materials consist of nigrosine, oleic acid, logwood dyes (soluble in water), potassium dichromate ($K_2Cr_2O_7$) with iron sulphate ($FeSO_4$), iron oxide (Fe_2O_3), lead chromate $Pb(CrO_4)_2$, safranines and methyl violet (basic colors).

Solvents: Naphtha, benzol, acetone and water.

Blacks: Preliminary Treatment.—Raw nigrosine is boiled with dextrine or glycerine to make it very soluble in water, sometimes boiled with paracoma in a steam kettle, then crushed or "cracked." The preliminary treatment depends upon its later uses.

The nigrosine is then treated by boiling with oleic acid (2 gallons to 10 lbs.) in a large steam-heated metal tank for two to three hours. It is then mixed with benzol, naphtha or acetone in about equal parts. This product is known as spirit black.

Hazards: In the use of naphtha, benzol, etc., the proper precautions should be taken, and the process of mixing and the storage of the volatiles confined to small detached buildings. These precautions are not always taken, however, and improper storage of volatiles in drums has been noted in large buildings, the material being used from the drums.

Tans.

Oxides of iron, lead chromate, etc., are ground in water in an ordinary paint mill, and this process is not hazardous except for storage of lead chromate ($Pb(CrO_4)_2$), which on contact with certain acids will liberate oxygen.

Logwood Dyes.

These are extracted from the wood itself, mainly by leaching. This process is not hazardous. Logwood dyes are mainly sold to and used by the trade in extract form.

Patent Leather Finishes.

These are usually made and used in Patent Leather Factories.

Principal Materials: Linseed oil, prussian blue (aniline dye), coach black (lampblack), pyroxylin, amyl acetate and naphtha.

Process: First Coat.—Boiled linseed oil is thinned with naphtha and applied by slicker iron or brush. Sometimes, however, the first coat may also contain pyroxylin dissolved in amyl acetate. This coat is baked in dryers or dried in the open air by sunlight. Second coat.—Linseed oil varnish, with Prussian blue or coach black ground in oil and containing also pyroxylin in amyl acetate, is used. This is applied to the hide during the day and baked on at night in large wooden or metal dryers. The coating is then stoned or polished, then brushed with linseed oil varnish and again baked.

The skins are now exposed to sunlight to allow the ultra-violet rays to produce a curing action. A later process has been introduced by some manufacturers substituting for sunlight the ultra-violet rays produced by large electric arc lamps.

Hazards: In most patent leather factories the materials used for coating are mixed on the premises, which involves considerable hazard. The process should in all cases be done in well-detached buildings without artificial light. Likewise all materials should be kept in detached sheds.

In the drying process, which is done in large steam-heated drying ovens, large volumes of inflammable fumes are liberated. These fumes are usually carried off through ducts or ventilator in the roof, but in some instances are condensed, thus recovering a portion of the solvents. If carried off by vents or ducts these should be of ample size and provided with fan driven by shaft located outside the oven. In the condensing process, which is only occasionally found, the apparatus should be located in a detached building and all piping secured, supported, and provided with proper explosion vents and screens.

In the rooms where coating is done fumes of the inflammable solvents are liberated to a more or less extent, and electric wiring and fixtures should comply with standard requirements. Only one day's supply of coating materials should be kept in these rooms.

It is apparent that smoking and carrying of matches should be absolutely prohibited on the premises.

Manufacture of Pyroxylin Solutions (Heel and Edge Finish).

Materials: Zinc oxide (white pigment), 16 oz. gun cotton (gun cotton dissolved in amyl acetate, 16 oz. to 1 gallon), acetone, castor oil, gum mastic and gum Demar.

Process: Zinc oxide is ground in a paint mill with castor oil, and to this mixture gun cotton dissolved in amyl acetate is added.

Acetone is sometimes used both as a thinner and solvent of gums. This mixing has been observed in tanks of about 35 gallons' capacity operated by mechanical stirring device, similar to that of a rubber cement churn.

Hazards: The storage and mixing of the above well-known inflammables and volatiles should be confined to well-detached buildings and never allowed inside main buildings. Electric apparatus should be arranged in accordance with standard requirements for hazardous places.

Manufacture of Shoe Pastes.

Brief History.

About one hundred years ago Day & Martin, London, England, patented a shoe paste of the following composition: linseed oil, lampblack and molasses or sugar in small amounts, mixed together, with the addition of sulphuric acid. When fuming stopped, vinegar or sour beer was added to make the liquid of the desired concentration. This dressing, probably the first on the market, was patented and is still found in use. In recent years many other preparations have been offered to the trade.

Materials: Carnauba wax, paraffine wax, turpentine, various colors. Carnauba wax is the main constituent of friction shoe pastes and is cheaper than beeswax. It is naturally exuded from the leaves of a South American palm, and in the crude form is greenish or yellowish, and so brittle that it can be readily powdered. It is completely soluble in ether and in boiling alcohol. Melting point lies between 176° F. and 194° F.

Paraffine wax consists principally of the higher members of the paraffine series of saturated hydrocarbons of the general formula $Cn\,H_{2}n+_{2}$. Its melting point varies with the mixture of hydrocarbons present; up to 118° F. is "soft"; over 120° F. it is known as "hard."

Processes: The desired mixture of the above waxes is melted together in a steam kettle and turpentine added when the waxes have become melted (temperature about 120° to 135°). The mixture is now heated for some time and desired colors added. Nigrosine previously boiled in stearic acid being employed for blacks, while for tan colors aniline dyes and potassium dichromate ($K_2\,Cr_2\,O_7$) are used, varying mixtures of colors producing the desired shades.

The hot paste is finally run into tins and cooled in a refrigerating room.

Hazards: Boiling should be done in a cut-off room in which electric appliances should be properly protected. Storage of turpentine, colors, etc., should be confined to detached buildings.

Manufacture of Shoe Dressings.

Materials: Aniline dyes, tragacanth gum and albumen soap for friction dressings. Wood alcohol, shellac, gums and dyes for non-friction dressings.

Processes: The tragacanth gum is soaked in water and swells, forming a thick viscous mass (a colloid). Dyes, soap, albumen, etc.,

are then added, with enough water to bring the mixture to the desired consistency.

For non-friction dressings the same materials are used, together with a small amount of wood alcohol in which shellac has been dissolved.

Hazards: The hazards are practically negligible since the materials are mostly in water solutions.

In the manufacture of non-friction polishes wood alcohol is used, and this should be stored and preferably used in a detached building.

II.

Leather Dyeing In Tanneries.

Brief Description of General Processes in Tanneries.

Skins are soaked; limed, which removes the hair and dissolves perishable matter; then delimed, which neutralizes the action of the lime on the skin and removes alkaline sulphides; pickled, which puts the skins into a clean and receptive condition for tanning liquor, as well as preserves them from decay. There are also mechanical and manual operations, such as trimming, fleshing and "working-out" to remove parts and substances that are superfluous and objectionable. Tanning is accomplished either by the chrome process principally or a vegetable tan process using quebracho extract or hemlock bark. This is carried on in large revolving drums or in pits. The leather is then shaved, dyed and stuffed, or it may be stuffed first, then dried, buffed and bleached. It is then finished.

a. Modes of Dyeing: There are two general methods of dyeing skins: first, by plunging, in which the entire skin is dyed, or second, flat surface dyeing, whereby only one side is colored.

b. Mordants: In order that a dye may penetrate the skin a mordant is applied. This is sometimes applied independently of the dye, but very often with it. The mordants more commonly used are sulphuric, phosphoric, tartaric, oxalic, tannic and acetic acids, or salts of these acids, together with iron sulphate, sodium and potassium chromates. Among the alkalies used are soda, potash and ammonia.

Acids must be used with all blue aniline colors and with most greens, as well as with many yellows and browns.

Alkalies are used with all red aniline dyes and kindred shades.

Curriers' Finishes.

Some Dyes Used.

Blacks: Nigrosine. This is a fine black amorphous powder soluble in water, and is the basis of most black dyes. It is sometimes used in combination with logwood dyes to produce a variety of shades.

Granular nigrosine is the above black powder boiled with paracoma. This is soluble in alcohol, water, naphtha, ether, etc.

Tans.

Tan colors are not altogether confined to the aniline dyes, but are to a great extent chromates, the varying shades being produced by a mixture of colors until the desired shade is obtained.

Light yellows are obtained by use of lead chromate, picric acid or methyl yellow (coal tar dye).

Reddish shades are produced mainly by oxide of iron (Fe_2O_3).

Chocolate browns by mixing nigrosine (black) with light yellow.

Russian red, which was formerly obtained with red wood, is now produced with aniline "juchtenrath" in three shades, G=light, GR=medium, R=dark. This color is dissolved in 100 parts of boiling water, the solution allowed to settle, and the clear solution taken for dyeing skins. Weak solution is applied first, and then the skin is passed through the second and third baths, each being stronger than the first.

Hazards of Dyeing in Tanneries.

The dyes used and method of their employment in the ordinary tannery make the hazard very slight, as the solutions used contain a large percentage of water.

In storage of chemicals it would be well to confine them to a detached shed at least 30 feet from main building, and to separate the dyes from the acids, as breakage and mixture is liable to cause spontaneous combustion.

Picric acid crystals should always be kept in water solution in storage.

Special Processes Common to Some Tanneries.

Coating Leather Splits.

Materials: Coal tar dyes, stains, etc.; purchased gun cotton dissolved in amyl acetate; acetone and amyl acetate for thinner.

Method of Application: The above materials are usually mixed in the tannery in small power-driven churns or by hand stirring in small tubs until the desired consistency has been obtained. This mixture is then known as "dope" or daub, and is used in the main building from open pans of about one gallon capacity. It is applied to the skins by means of a brush or hand mop.

Hazards: This process of coating splits is very hazardous and should be confined to a detached building, as should all mixing and storage of materials. It should never be allowed in the main building. It is found in main buildings at present in New England.

Special processes of the sheep and goat skin tannery involve a hazard not ordinary to the usual tannery, and may be treated briefly here as follows:

Finishing Goat and Sheepskins (Bookbinding Leather).

The finishing of bookbinding leather requires the use of varnishes. These are applied either by air brush or by hand to the flat leather.

Oil Varnish.

This is a mixture of colors which also contains shellac cut by wood alcohol, and is applied to the leather to produce a lustrous finish. It usually contains castor oil to give a lasting quality to the finish.

Pyroxylin Varnish.

This is a composition of colors which contains (purchased) gun cotton dissolved in amyl acetate. The mixing is done inside and applied usually by hand brush.

Hazards.

The process of pyroxylin coating is hazardous and should be confined to a detached building, together with the storage and mixing of the compounds used.

III.

Blackings and Stains as Used in Shoe Factories.

General Description of the Processes.

The shoe factory processes where blackings and stains are used consist mainly of cutting, treeing and finishing. The stains used include water colors, naphtha black and colored waxes which are purchased ready to use.

A. Bottom Finishes.

The stains used for bottom finishes are water solutions of varying colors, and are usually applied by brush. Sole and heels are ordinarily colored in a similar manner, and are then waxed and buffed by mechanical operation.

Hazards.

Since these dyes are mostly water colors, there is no hazard in their use.

B. Upper Finishing and Retouching.

The leather as found in the shoe factory has previously been dyed to the desired shade in the tannery, and dyeing in shoe factories is limited mainly to re-touching and finishing.

Finishing.

The uppers are finished in the treeing room, where a water color is applied and leather is rubbed with heated irons to give a gloss. Where a dull or non-lustrous finish is required, the stains usually contain an oil.

Upper leathers, after being cut from the hide, have a "raw" or uncolored edge, and to color this naphtha black is used. This is the dye nigrosine dissolved in naphtha and is purchased ready for use, but it is thinned with naphtha at the factory, and is mostly used from open dishes of about a quart capacity, the cut edges being immersed in it.

Retouching.

The uppers are sometimes damaged while the shoe is being made, and retouching is necessary. This is usually done by girls in the shipping room.

Purchased solutions of dyes and stains in containers of about half a pint capacity are usually on hand. The stain is applied by a brush and then buffed by hand.

In patent leather retouching colors are employed which contain pyroxylin in solution with amyl acetate and acetone. These are also

applied by brush and a glossy finish obtained by applying ether, which acts as a quick solvent and removes all streaks. Ether is used from very small bottles, and not over five pounds is usually inside the factory.

Hazards.

Naphtha black is hazardous, and the usual precautions governing the use of naphtha apply to its use. The presence of an open flame and the usual smoking hazard in shoe factories should be avoided. If large amounts are kept they should be stored in detached sheds at least 30 feet distant from main building, and a day's supply only permitted in the factory.

The principal hazard of retouching is that of open flames coming in contact with inflammable liquids or thin vapors. The amounts used, however, are generally small, and the danger is thus greatly reduced. Main supply of ether should be kept outside the building, and it should be used in a safety can.

C. Heel Finishes.

Up to within a few years heel finishes have been confined to water stains, blackings and waxes of a non-hazardous nature.

Ladies' White Heel Finish.

Pyroxylin solutions have formerly been applied by a brush, but this was a slow method, and has been replaced by the spray method.

Air Brush Method.

The apparatus consists of an air spray under a metal hood, with a blower attachment usually connected directly to the blower system of the shoe factory. The solution used consists of a mixture of acetone (ethyl-methyl-ketone) in which gum Demar or gum mastic is dissolved, 4 oz. solutions of pyroxylin (gun cotton dissolved in amyl acetate) and zinc oxide, which has been ground and mixed in castor oil. The proportions are about 6 lbs. of zinc oxide to 1 gallon of a mixture of these solutions. Similar mixtures have been found to contain impure acetone, but they are all of about the same composition. The commonly found mixture known to the trade as Uni-Lak is similar in composition to the above and used in a similar manner.

Hazards.

The solution used is inflammable, but the zinc oxide used in large amounts greatly reduces its inflammability, as zinc oxide will not burn.

The spray method used in this process has the tendency to reduce the volatile and inflammable solvents employed to a fine state of physical sub-division, and in this state explosions might possibly occur. The blower system for carrying off these fumes should be independent of the factory blower system, and should be carefully built and installed.

Spraying should be done under an all-metal hood, and the preferable arrangement is to have the fan exhausting directly to the outside of the building.

It is not desirable to keep over a day's supply of this solution in the building, and storage should be confined to a detached shed at least 30 feet distant.

D. Cleaners.

Owing to previous war conditions and the manufacturing of "millinery" shoes with their variegated shades, also the making of canvas shoes, it has become necessary to clean the uppers. The cleaners used are naphtha, gasolene, ether and carbon disulphide; also non-hazardous compounds as soap, ammonia, etc., are used.

Usually the amounts employed are small and are used with a sponge or brush; this is done in the packing room. Quite frequently excessive amounts of the inflammable materials are on hand. These should be stored in a detached shed and only a day's supply allowed in the building.

Occasionally a dozen or more of these uppers are immersed in several gallons of gasolene, before finishing, to remove large oil spots. Uppers are allowed to drain back to the container and are then hung up to dry. This has been observed in the stitching room of one shoe shop by the writer.

IV.

Waterproofing of Leather Soles.

This process is found in many shoe factories, and where found may or may not involve a hazard, depending upon the composition of the material used. Waterproofing mixtures may be divided into two groups, one containing naphtha and the other consisting mainly of petroleum residues.

The naphtha is used in order to make the solution sufficiently thin to penetrate the leather rapidly. Where no such thinner is used, it is generally necessary to heat the material in order to accomplish the same results.

Some of the more common materials used are the following:

Naphtha Mixtures.

Celasol.

This is a black liquid with a viscosity greater than that of molasses. It contains 25-30 per cent. of naphtha in which heavy asphaltic materials are dissolved. It is made, principally for producing a shoe filler, by mixing with ground cork. Soles may be waterproofed by brushing on the material.

Hazard: This substance is readily inflammable, and the usual restrictions governing naphtha-thinned products should be observed.

Lander's Process of Waterproofing Soles.*

The compound used contains 52 per cent. of gasolene, with unrefined petroleum (residue in distillation of petroleum oils and rosin). This solution is mixed in the factory to a volume of about 100 gallons and used from dip tanks 5 x 2 feet and 4 feet deep, heated by steam coils to a temperature of about 145°F.

The soles are placed on wire containers and lowered into this mixture by overhead pulleys. At the end of about five minutes' immersion they are raised and allowed to drain over the tank, and are then ready for use.

* Out of use.

Hazard: The hazard of this process lies in the well-known dangers in handling gasolene, the open dip tank and, in sprinklered factories, the probability of water from sprinklers operating in case of fire and overflowing the tank and spreading the gasolene compound. The hazard is increased by the high temperature employed.

The work should be done in a detached fire-resistive building and the materials not used in the main building.

Note: This process was developed and used during the manufacture of U. S. Army shoes, as government requirements made waterproofing necessary, but at the present time it has been discontinued.

Viscol.

a. This is a mixture of compounds made by treating certain vegetable oils together with some fats by chlorine and sulphur. The unsaturated hydrocarbons probably unite with the chlorine or sulphur, or both, making a thick viscid liquid or soft sticky solids. Viscol in this state is not readily inflammable.

b. When used in shoe factories it is necessary to thin viscol with benzene, naphtha or some similar material in order to insure penetration into the leather. This thinned mixture is applied in one of two ways, by immersion or by coating with a brush. Tanks of small capacity usually are used.

Hazards: These are usual to naphtha-thinned compounds and the usual safeguards should be employed. Main supply should be in a detached shed and only a day's supply allowed in the main building. Where it is desired to use more than five gallons at a time, the work should be done in a shed detached at least 30 feet.

Petroleum Residues.

Dizer's Resisto.*

This is a solid grease, softer than paraffin, and is used for waterproofing soles in a wooden tank lined with galvanized iron and containing a steam coil which heats the grease to about 150°F. Melting point, 98°F. Flash point, 400°F. Burning point, 420°F.

Hazard: This compound is safe as ordinarily used.

Brunol.

This is a dark brown, almost black, liquid with a specific gravity of .95. It is probably a mixture of tar with some creosote oil and heavier petroleum distillates. Flash point in closed cup tester was found to be 240°F. It takes fire and burns readily at a temperature of 310°F.

Hazard: Brunol is used in metal tanks of about two barrels capacity, usually heated by steam coils to a temperature of 110-135°F. Cut soles in racks are immersed in this solution for about 20 minutes and then suspended over the tank to dry. This substance is safe to use, as flash point is high, but tanks should be provided with automatic metal cover and a barrel of sawdust and soda kept on hand.

* Out of use.

J. & T. Waterproof Filler.*

This is a substance of about the consistency of vaseline, dark brown in color and having an odor resembling whale oil. When heated, it commences to soften at 100-110°F., and at 140-150°F. it completely liquifies. Its flash point is very high, being over 450°F.

Hazard: No naphtha or solvent is employed in its use, and this can be considered a non-hazardous material.

"X-L-N-C" (Excellency).

This is a black liquid with a viscosity similar to molasses and an odor of creosote oil. The flash point is about 230°F. and burning point 300°F. (closed cup tester).

Hazard: This is a safe material to use, but where dip tanks are employed they should be of metal and provided with a cover which should operate automatically with fusible link.

Repello.*

Similar to Resisto, described above.

Re-Lyte.

Dark brown colored oil, probably a petroleum derivative. Flash point, 362°F. Burns at 392°F.

Hazard: Non-hazardous solution at ordinary temperatures.

V.
Fires.

The record given below contains representative instances from many fires, the origin of which can be traced directly to the manufacture and uses of the materials described in the preceding pages.

Blacking and Stain Manufacturing.

No. 1, December 3, 1912. Steam heated kettle holding 20 gallons gums cut with acetone ignited by open gas flame. Loss, $100.

No. 2, March 19, 1917. Compounding colors with benzol which took fire by static spark. Loss small.

Tanneries.

No. 3, July 23, 1911. Cause unknown. Fire originated in the daubing room, where "dope" was being applied to leather. Loss, $10,000.

No. 4, Date (?). Cause: Explosion of chemicals inside buildings where pyroxylin compound was stored. Loss, many thousands.

Shoe Factories.
(Blackings and Stains.)

No. 5, February 2, 1903. Cause: open flame coming in contact with fumes of naphtha black. Loss, $28.

No. 6, October 14, 1903. Cause: Naphtha black took fire when gas jet was lighted. Loss, $9.95.

* Out of use.

No. 7, April 25, 1907. Cause: Spontaneous combustion of a stain which, leaking from container, soaked sawdust and took fire. Loss, $1065.

Shoe Factories.

(Cleaners.)

No. 8, January 30, 1909. Cause: Vapor from naphtha, used as a cleaner, ignited. Loss small.

No. 9, July 22, 1912. Cause: Benzene rag used for cleaning shoes came in contact with open flame. Loss, no claim.

Shoe Factories.

(Waterproofing Compounds.)

No. 10, September 5, 1907. Cause: Fumes from viscol tank ignited in contact with open flame. Loss, $165.

No. 11, May 22, 1916. Cause: Contents of viscol tank boiled over and took fire. Loss small.

No. 12, January 1, 1918. Cause: Tank of petroleum grease and rosin mixture thinned with gasolene took fire by friction spark generated by contact with metal cover and tank. Loss, $350.

References.

Chemical News, *Vol.* 35, *Page* 133.
J. Holbling, (*Zeit., Ange. Chemic.*).
Leather Trades Chemistry, *S. R. Trotman.*
Leather Manufacture, *Alexander Watt.*
The Manufacture of Leather, *H. G. Bennett.*
Practical Tanning, *Louis A. Flemming.* (3rd Edition.)
Roger's Industrial Chemistry, (2nd Edition).
Commercial Organic Analysis, *Allen.* (Vol. III, Part I.)
Manufacture of Lubricants, Shoe Polishes and Leather Dressings, *R. Brunner.*

Department of Fire Record.

Film Exchange Fire, Pittsburgh.

January 7, 1919.

Special Report by National Board of Fire Underwriters' Committee on Fire Prevention and Engineering Standards.

The description of this fire may properly be preceded by a statement of the conclusions arrived at for the guidance of those responsible for the safe storage and handling of film in other cities, in most of which conditions are not far different from those described in this report.

Motion picture film as now almost universally used in this country has a nitro-cellulose or pyroxylin base, and is highly inflammable. Numerous tests have been made on quantities of film, both as to method of storage and fire protection required. These tests have emphasized that under proper restrictions the storage and handling of this product may be made reasonably safe, but if these protective measures are not carried out the hazard, both to life and property, is extremely severe.

This fire forcibly emphasizes the lessons taught by previous similar fires in Kansas City, Chicago and Detroit, as well as Pittsburgh itself. In this case practically none of the necessary safeguards were observed, and the result was just what might have been expected.

Vaults were provided in each film exchange, but in no case was extinguishing equipment installed. A series of tests conducted by the Eastman Kodak Company, in Rochester, in 1915 and extending through to 1917, indicated the absolute need of the installation of automatic sprinklers to prevent disastrous results from the rapid combustion of this highly inflammable material. These tests and experiments have been given wide publicity.

It has been known for many years that it was essential to vent adequately all storage places of nitro-cellulose film to care for the large volume of gases of decomposition which are, under certain conditions, highly explosive. Nominal compliance with this requirement was carried out in the storage vaults in the building affected, but in a manner almost unbelievably senseless; some of the vaults were vented, not to the outside air, but directly into the building, immediately above the heads of workers; others were vented into shafts that were too small or into a shaft which was closed in its upper end, thus making the vent useless.

Double doors were provided on all vaults, but these might just as well have been omitted, as in every case except one they were left wide open, and in addition the lock was so arranged that they could not be closed even if an attempt were made.

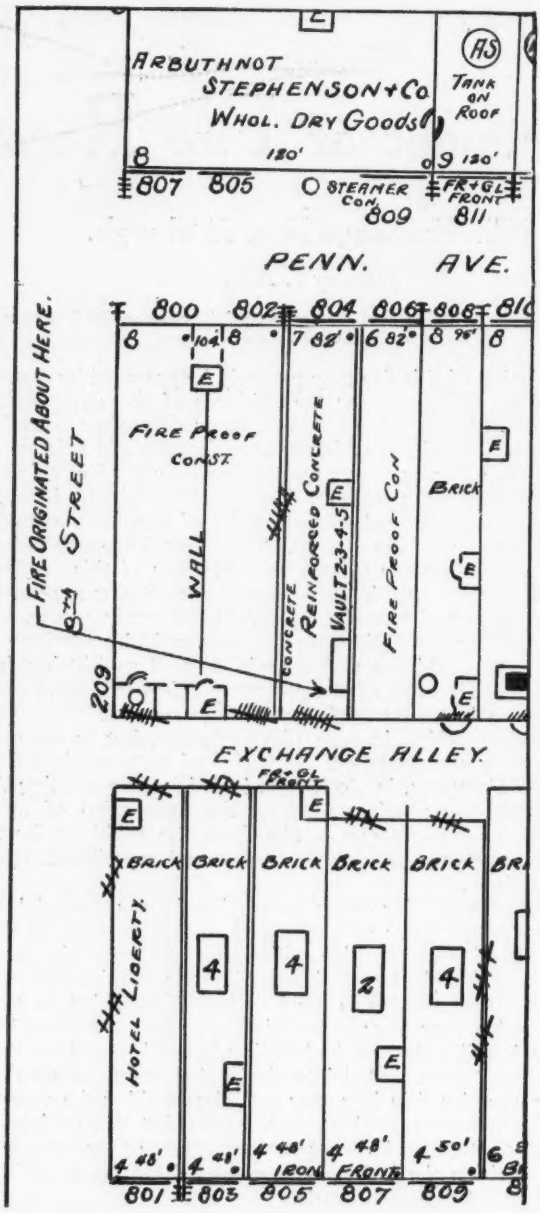


Fig. 1. Plan showing building in which film fire occurred at Pittsburgh.

Fig. 2. Shows hazardous location of film exchange in congested section of city.

Evidences of poor housekeeping were apparent even after the fire; what conditions actually were cannot be determined at this time. In one exchange employees slept and cooked in the same room where naked reels of film were exposed. In most of the exchanges practically no attempt was made to prevent the ignition of film through the use of metal containers, although many of these containers were stored empty in the vault. Excessive amounts of film were kept outside the vault.

All these conditions existed although prohibited by a city ordinance approved May 2, 1917.

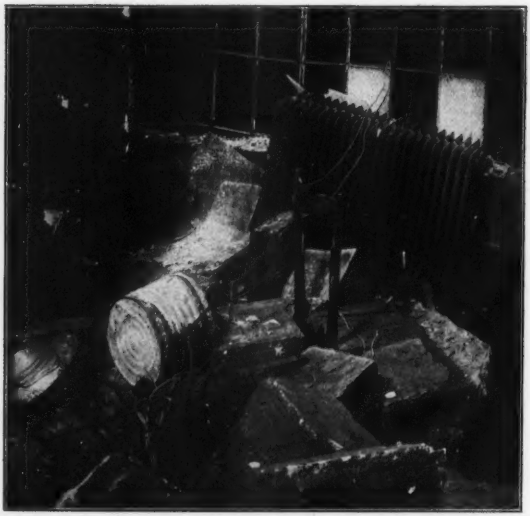


Fig. 3. Fourth floor rear, corner of vault shown at left. Door and vent faced window. Vent opened direct to room. Terra-cotta blocks from partition blown in by explosion below. Note radiator not screened or protected.

The building was seven stories high, of so-called fireproof construction, but with many defects from the standpoint of fire resistance. That it was not totally destroyed was due largely to the very rapidly combustible character of the contents.

Safety to life features had been almost entirely disregarded. There were no fire escapes, and stairways were inadequate and partly unenclosed, so that there was no possibility of occupants on an upper floor descending by the stairs to the street; in addition, the main stairway permitted the extremely rapid spread of the products of decomposition to all parts of the building, with a consequent spread of the fire when these gases exploded.

The storage and handling of film was conducted on the second, third, fourth and seventh floors, and at a prior time on the fifth floor. On the sixth floor was a skirt factory with numerous employees and a storage place for a distributor of disinfecting liquids.

Under the conditions existing in the building a loss of life might be expected in any fire, but with a material as quick-burning as nitrocellulose film there could be no question but that there would be serious loss of life on the upper floors in case of a fire.

The cause and place of origin of the fire are not definitely determinable. There were many points where it could have originated and many conditions which could have started it. Radiators in the building were heated by steam, yet were unprotected, and it would have been

possible in any exchange to have caused ignition through the placing of a reel of film against such a radiator. The rumor is that smoking was indulged in. A carelessly thrown match would have ignited a reel in many of the places where it was left exposed.

The fire undoubtedly started in one of the film exchanges; evidence points to the fourth floor as being the point of origin. With no protective devices and a considerable amount of inflammable film in the workroom, a fire of considerable magnitude undoubtedly soon resulted; and, if it did not start in or near the vault, soon spread to it. The evidence of tarry matter on the ceiling shows that a large volume of gases of decomposition was liberated, and it is probable that these spread through the floor and to other parts of the building. An explosion in these gases ignited films exposed on other floors, particularly the second and third, and the fire had ready access to the vault storage through the open doors and ignited the contents, which, on the second floor, consisted of over 8,000 pounds of film. Witnesses state that a heavy explosion occurred on the second floor; the condition of the building confirms this, as the ceiling of this room was wrecked, the end wall blown out and partitions on upper floors above the wrecked ceiling blown in.

Many parts of the building are considerably scorched, but are otherwise little injured. The duration of the fire in the films was very short, but the heat was intense at points where sufficient air was available to secure complete combustion. Exterior walls are spalled and wired-glass windows cracked and destroyed. The blast of the explosion with its spread of flame undoubtedly added largely to the great loss of life, both from burning and from panic. Many of the dead were killed by falling from the upper floors; in their excitement they may have jumped, but it is very probable that some of them were blown from the windows.

Following the explosion, with the destruction of the rear wall, the heated gases of decomposition were ignited and a volume of flame spread the fire across the rear alley to opposite buildings. The magnitude of this flame was particularly commented upon by observers.

The loss of life was excessive. In the shirtwaist factory bodies of four girls were found near the door leading to the stairway, their only means of exit, which had been completely cut off by the mass of flame extending up the stair shaft. More than a score were injured.

The circumstances of this fire and the fact that similar fires have occurred in the past and will continue to occur unless the conditions of storage and handling are radically reformed, all point to the necessity for early and drastic action toward the enactment and enforcement of adequate provisions covering the storage and handling of nitro-cellulose film. The essential features requiring attention are as follows:

First.—Reduce the amount of film exposed to a minimum consistent with the actual operation of the business. This would prohibit the leaving of film exposed on racks and tables in the various rooms of the exchange, and would require rigid inspections on the part of the fire department to assure good housekeeping by the employees of the exchange.

Second.—Prohibit the handling of film or its storage except in rooms and vaults adequately protected by automatic sprinklers, properly

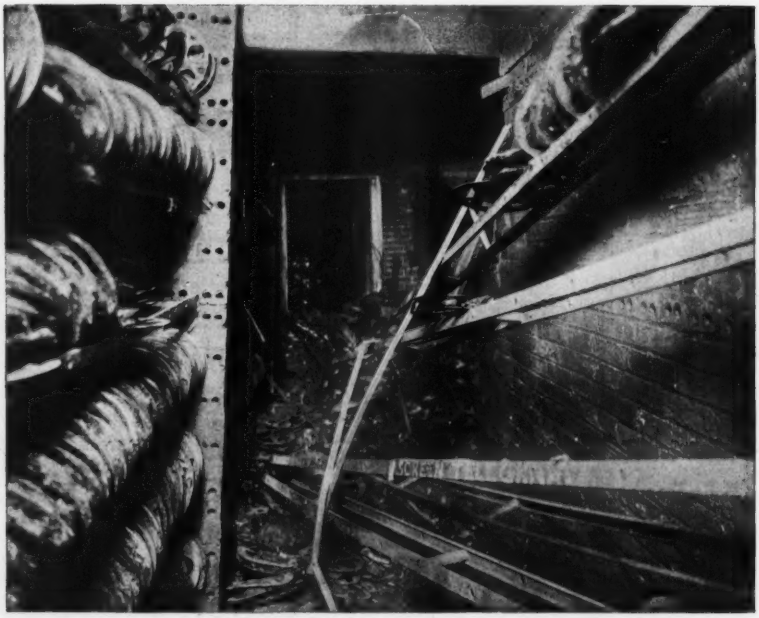


Fig. 4. Interior of vault on 2nd floor. Contained 8,500 lbs. of film, none in containers. View taken from just inside doorway. Although door was open, the end and one half of right side wall were blown down by explosion that was not intense in interior of vaults.

supervised. The nature of the product requires vaults to be equipped with at least one head to each 800 to 1,200 pounds of film, and special heads provided over points where film is handled.

Third.—Have all films stored in vaults of fire-resistive construction, with an ample vent opening from each direct to the outside of the building and preferably extending to the roof. Doors to be of a type which can be readily opened and closed, and which will be kept normally closed.

Fourth.—Require all openings, stairways and passageways between floors to be adequately cut off and protected to prevent the passage of gases of decomposition to other floors.

Fifth.—Require ample means of escape from upper floors, and prohibit stairways not leading continuously from the top floor to the street.

Sixth.—Unless such laws are enacted and strictly enforced, with the full co-operation of those responsible for the handling and storage of film, the only alternative is the elimination of the use of the inflammable nitro-cellulose film and the substitution of the non-inflammable acetate film. Such substitution will undoubtedly be the eventual solution of the problem, but it is reported that at the present time a full supply of the acetate film cannot be obtained to meet the demands of the motion picture industry, and as now manufactured the non-inflammable is stated

Fig. 5. Rear of building, showing wreckage due to explosion and brickwork spalled from intense heat when gases of decomposition reached outside air and sufficient oxygen was available to permit burning.

to be somewhat less satisfactory than the nitro-cellulose film. Further, the enactment of laws prohibiting the printing of motion picture plays on nitro-cellulose films will not remove the hazard which will exist for many years from the present stock of such film, which in the aggregate is very large.

Construction of Building.

The location of the building is 804 Penn Avenue, and its area 21 feet by 100 feet.

The original building was a four-story structure, with rear 55 feet of left wall an old 18-inch brick wall, and columns, girders, floors and the 4-inch side walls of poured concrete. Three stories were later added, using protected steel truss supported on party walls of adjacent buildings. Partitions are wood, terra-cotta and some expanded metal lath. Front wall is green glazed tile, open construction, the three upper floors having steel frames and wired and ribbed glass windows. Rear wall was brick for the first three stories; the upper four stories were steel

Fig. 6. Second floor. Shipping and receiving room. 36 exposed reels on rack. Evidence of unprotected film apparent in other places. Note blackened interior, showing deposit from gases of decomposition which caused explosion.

frames, with two lower lines of panes of wired glass, next two of plates and top two of prism glass, at each story.

There was one elevator shaft at center of building from basement to seventh floor, partly enclosed in brick and tile, excepting seventh floor, which was open; doors were steel with wired-glass panels; metal frame windows with ¼-inch plate glass in front wall of shaft at each floor.

Concrete stairs at front of building from street to fourth floor were in terra-cotta hallway with wood and thin glass doors. From fourth to seventh floor stairs offset and adjoined elevator shaft; semi-winders near bottom of runs. Stairway to roof very narrow, of iron grid construction and had to be reached through private office.

Fig. 7. Four story building at rear. Wood and glass directly exposed across alley. Effect of hot blast of flame clearly shown on upper floor. Windows in building in background were broken by explosion.

The fire exit stairway is a concrete stairway from basement to fifth floor only; 9-inch risers and 8-inch treads; width only 2 feet 6 inches and no hand-rail. This stairway was enclosed in a 4-inch terra-cotta partition with tin-clad fire doors, not self-closing, but provided with panic hardware. Doors were so hung that when open they obstructed passage from above. Landings on the fourth and fifth floors are wood. Stairway could not be used by all occupants of a floor, as entrance was through poster and shipping rooms.

Skylights located over seventh floor were standard.

Film vaults were located on second, third, fourth, fifth and seventh floors; 8-inch hollow brick and tile, resting on reinforced concrete floor, with double safe doors, not self-closing. No sprinklers in vaults or examination rooms. Reels not kept in containers.

Second floor vault was 975 cubic feet; vented through expanded metal lath and plaster duct into a 1-foot by 2-foot terra-cotta pipe shaft, which was sealed at roof. About 1,750 reels, 8,500 pounds, of film in storage.

Third floor vault was 250 cubic feet, vented through opening of 470 square inches direct into repair and examination rooms. About 350 reels, 1,750 pounds, of film in storage.

Fourth floor vault was 775 cubic feet; vented through opening of 470 square inches direct into repair and examination room. About 1,200 reels, 6,000 pounds, of film stored.

Fifth floor vault (unoccupied) was 660 cubic feet; vented through

an expanded metal lath and plaster duct about 7 feet long, extending through examination room into a 4-inch brick vent shaft of 320 square inches, and also connecting into the service pipe shaft to which the vault on the second floor connected. On the sixth floor an open flue ring and on the seventh floor a 5-inch stove pipe from a gas-heated melting pot entered this vent shaft.

Seventh floor vault was 250 cubic feet. Vent, through roof, is 1 foot by 2 feet. Vault open into an extension, 5 feet by 8 feet by 10 feet, built of 4-inch cement on expanded metal lath, with tin-clad fire door, not self-closing, and vented back into repair and examination room and offices; this room was used for the storage of posters and contained 68 open reels of films. Fire did not involve this part of the building.

Between the repair and examination room and the shipping and poster rooms the fire division partitions were 4-inch terra-cotta with tin-clad fire door, not self-closing, or of steel frame and wired glass.

There was no sprinkler or standpipe protection.

Three 2½-gallon chemical extinguishers were located in store room on first floor and two special liquid extinguishers on second floor. No water and sand pails.

Vapor-proof electric lamps and outside switches were installed in connection with the vaults.

Heating was by low-pressure steam; radiators not protected.

The character of the occupancy was as follows:

Basement: Front, storage; rear, heating boiler.

First Floor: Wholesale ladies' suits, dresses, etc.

Second Floor: Film exchange; large number of exposed films; 36 open reels found on open portable rack in center of room. A poorly protected and unsafe cleaning machine was also in this room.

Third Floor: Front, stock of posters; rear, film exchange; open films scattered about room; in the poster and shipping rooms provision was made for three men to sleep, and they cooked their meals in this room on electric broiler.

Fourth Floor: Front, surplus stock ladies' suits, etc. Rear, film exchange; open films in rooms.

Fifth Floor: Vacant.

Sixth Floor: Front, small stock of liquid soap in steel drums; eight employees. Rear, manufacturers of ladies' skirts, fourteen employees, ten of whom were not working at time of fire owing to it being the Greek Christmas.

Seventh Floor: Front, film exchange. Sixty-eight open films in vault extension and a number in examination room and office. Examination room not separated from office. Rear, monotype composition, four employees.

Details of Fire.

A civilian, seeing smoke and hearing explosion, sent in an alarm at 4.57 p. m.

The fire probably originated on the fourth floor and spread rapidly by means of stairway and elevator shaft through the entire building. None of the films in the vaults or examination rooms were in containers.

The heavy smoke and vapors of burning and decomposing film spread rapidly through the building, and as it was not properly vented to the outer air the escape of the employees on the upper floors was cut off. These gases of decomposition, mixed with air, exploded on subsequent contact with flame. These explosions shattered the rear windows, did considerable interior damage and allowed the spread of the gas to the alley, where it burned fiercely. None of the vaults on second, third or fourth floors had doors closed.

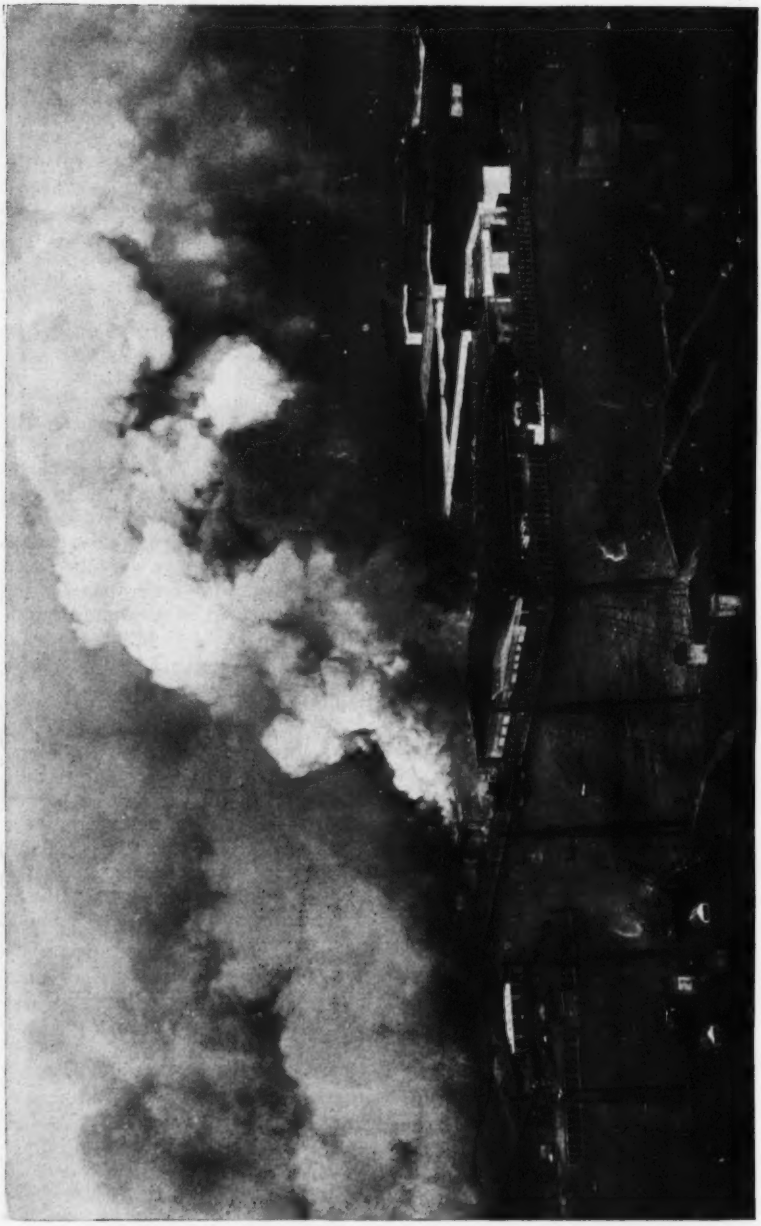
The blaze was extinguished by the City Fire Department. First alarm called out Engine Companies 3, 18, 19, 32, 33 and Truck Companies 1 and 5. Immediately on arrival (5 p. m.) the District Chief sent in second and third alarms, calling out Engine Companies 2, 30, 15, 46 and Truck Company No. 12, also Nos. 1, 7 and 4 and Truck No. 6. Two special calls were sent out at 5.00 and 5.12 p. m. Truck No. 1 had one net and Truck No. 5 two nets. Fire was under control at 5.30 p. m.

Loss of Life.

Ten dead (four women and six men) and a score injured. Of the dead, four were found in the Superior Skirt Company's room on the sixth floor, one in the front room on the fourth floor, one in the passageway to stairs on the fourth floor, and the remainder lost their lives by either falling or jumping out of the sixth story front windows. Five persons were rescued from the sixth floor by means of fire department ladder. This ladder collapsed owing to failure to kick in the dogs, and two fire department officers were seriously injured. Four men on the seventh floor, by breaking through skylight, escaped to adjoining buildings.

Damage.

The woodwork throughout the building is burned; the stocks total losses; and the fourth floor rear fire exit stairs and tile partitions enclosing same are blown out. Vault on the second floor blown out and films in all except on the seventh floor destroyed. The fire communicated to the building adjoining on the right, occupied by a firm of wholesale hatters, by way of the front windows. It also jumped across the rear alley to buildings at 803-805 Liberty Avenue. No. 803 was unoccupied; No. 805 was occupied on the first floor by a jewelry company, and the remaining floors by a concern handling drawing materials and architects' supplies. Scores of plate-glass windows within one square of the building were shattered by the explosions.



Fire in Fertilizer Factory and Railroad Terminals, Savannah.

Fire in Fertilizer Factory and Railroad Terminals, Savannah.

February 14, 1919.

Special Report by A. M. Schoen, Chief Engineer, South-Eastern Underwriters' Association.
(Member N. F. P. A.)

Fire was discovered by the assistant manager and master mechanic of the Southern Fertilizer and Chemical Company in the rock conveyor tunnel near the motor room. Their attention was first caught by the odor of smoke, and directly after the flames were seen from another point in the building.

Occupancy and Construction of Buildings.

The fertilizer factory in which the fire originated consisted of rock shed, bag room, mill building and dump shed, all of ordinary frame construction, dirt floors and composition roof. Dump shed was 480 x 130 feet and one story in height; mill building, 35 x 40 feet, five stories; rock shed and bag room, 62 x 67 feet, one story. Processes: crushing and elevating phosphate rock, mixing with sulphuric acid and other fertilizer ingredients, passing to dump shed and loading on cars. Plant was operated throughout by electric power furnished through submarine cables and overhead wires from central station in Savannah.

Seaboard Air Line buildings burned consisted of (1) a brick loading shed, 138 x 100 feet, standard 16-inch walls, wood floor partly on piles, and wood roof sheathing covered with composition; used for storing sodium nitrate in bags; (2) four cotton warehouses, 200 x 400 feet, 230 x 400 feet, 200 x 200 feet and 230 x 250 feet, respectively; two of these built with standard 16-inch pilastered reinforced concrete walls on two sides and the remainder with similar walls on three sides, with open sides to tracks; floors, brick and wood on the ground; roofs, wood sheathing, covered with approved composition; openings protected by sub-standard tin-clad fire doors; (3) two frame and iron-clad miscellaneous loading sheds, open sides, wood floors partly on piles, wood roof sheathing covered with standard composition, standard 16-inch end fire-walls, sub-standard fire doors; (4) one cotton shed of same construction, 135 x 150 feet; (5) lumber dock on piles.

Extent of Damage.

All of buildings described above were a total loss, except the reinforced concrete walls, which calcined to a depth of one-half inch to an inch, and pilasters slightly spalled. None of these walls show any signs of cracking or giving way and are apparently as strong as ever. The unpierced brick fire-walls also stood the heat well, showing no very material signs of deterioration. Practically all the contents of these

buildings were a total loss, except in the case of the fertilizer plant, where there will be a large salvage.

Cause of Fire and How Fought.

The cause of the fire was not determined. Every indication points to its having originated in the motor room of the rock crusher building of the Southern Fertilizer and Chemical Company, which room was about 10 x 6 feet, about 20 feet above the ground and in the southeast corner of the building. The motor was a 20-horsepower, 2-phase, 220-volt, 60-cycle, induction type, with squirrel cage armature, and was belted to a jack shaft, from which an endless belt, bucket type rock conveyor was driven. The controlling apparatus was on the floor below, and from the evidence obtained could have played no part in the origin of the fire. It was learned that the motor and machinery were running freely for some minutes after the fire was discovered, and had been so running for seven and a half consecutive hours previous to the fire. The master mechanic claims to have inspected the bearings and found them cool within the hour, and it was also claimed that no waste was used in the room.

Immediately upon discovery the alarm was turned in over the A. D. T. system, with which all properties on the island were equipped, and the central office records in Savannah show that the alarm was received at 2.34 p. m. The automatic whistle sounded and the private fire brigade of the Seaboard Air Line Terminals responded promptly. In the meantime the employees of the Chemical Company had two lines of hose from the outside hydrants in service, and these two streams, which were full standard, were playing on the building in about three minutes. It was reported that nine streams were used on this fire at one time, but there is some doubt in the writer's mind as to the accuracy of this statement. About fifteen minutes after water was first put on the flames the 1,000-gallon electric pump of the Seaboard Air Line ceased to function as the result of the overhead supply wires (which ran immediately adjacent to the Chemical Company's plant) burning in two and falling to the ground, and the pressure dropped to the point where the water supply was of no further practical value. By this time, however, the building was doomed, and so far as this property is concerned, it was probably fortunate that the pressure fell, as this prevented the washing away of much of the large stock of fertilizer materials that were in huge piles inside the building, thus increasing the salvage to be expected. This building is reported to have collapsed about 45 minutes after its ignition.

At the time the chemical plant buildings were burning the wind was blowing due east, or straight down the Savannah river at a velocity of about 33 miles per hour, and the flying embers began at once to be carried onto the other three railroad piers. Pier No. 4 was 175 feet east of the chemical plant, though this space was reduced by the freight cars standing on tracks between the two buildings. However, the very nearness of this pier seems to have contributed to its safety, for most of the flying brands were swept over it, and the buildings and contents escaped

without damage, though this was accomplished by constant patrolling and wetting down at many points.

On the east side of this pier and in the slip a British tramp steamer was lying at her moorings, and soon the canvas of the crow's nest caught fire, burning strips of the cloth being torn away by the wind and whirled off in the direction of Pier No. 3, with its large stores of cotton and nitrates. Spectators from across the river claim to have seen this burning canvas swept under the partly closed doors of the cotton sheds. Whether this may be accepted as an actual fact or not, unquestionably embers or sparks were carried by the wind into the corrugated iron shed on the west side of this pier and the brick nitrate building adjoining, as well as into the large cotton warehouses just east of these. The latter had standard reinforced concrete walls on two or three sides, as the case might be, but had no wall on the side or sides toward the tracks, as space was left open for unloading and loading the cars. Evidently the sparks and embers found entrance through the open sides, and where the openings faced away from the fire the entrance of the embers must have been due to eddy currents in the air creating draughts in unexpected places. The brands also reached Piers 1 and 2, but there the damage was limited.

It was impossible to learn the maximum number of streams of water used at any one time. Claims of as high as 49 streams were made, but considering the fact that only two 1,500-gallon pumps were supplying the mains, this statement is considered highly improbable. After the electric pump had gone out of commission, water was supplied to the mains from the two steam pumps mentioned above and from the 100,000-gallon elevated tank, which was reported full at the beginning of the fire. The electric pump was only out between an hour and an hour and a half, as the wires were repaired within that time; however, the valve in the main leading to the electric pump seems to have been closed after its failure, and it played no further important role. The steam pumps are supplied by three boilers, one 100-horsepower and two 90-horsepower. It appears that the 100-horsepower boiler was under full steam pressure when the alarm was sounded and the others, in which water was hot, got up steam in 30 minutes. During most of the time the fire was burning the pressure on the mains seems to have been very low, owing to the heavy demand made on them, not only for water being actually used on the fire, but also on account of hose which were dropped after being used and hydrants left running when they should have been shut off. In one of the nitrate sheds (No. 7, Pier No. 3), where there was large storage in bags, sparks caused 220 incipient fires, which were extinguished with buckets of water. At the Atlantic Compress Company a number of bales of cotton on the loading shed caught fire, but were extinguished with buckets of water until a hose stream could be brought into service, after which the cotton was thoroughly drenched and further fires prevented.

At the beginning of the fire cotton was being handled and sampled on the platforms of some of the sprinklered cotton warehouses. This cotton was quickly rushed into the warehouses and the doors closed. Apparently sparks must have fallen on some of these bales while in the open and were not discovered, for a short time later sprinkler alarms sounded, and

on opening Section No. 2 of Warehouse A it was found that six sprinkler heads had opened. While a number of charred bales were found, the damage was almost negligible. Exactly the same thing occurred in Section 2 of Warehouse C, except that seven heads opened, with the same result.

Apparatus Used.

There was no fire apparatus on the island, entire dependence having been placed on the large number of hydrants kept at all times with hose attached. Several small tugs were on hand, but some of these failed to respond at all and those that did attempt to render assistance were so late doing so and were equipped with such small pumps that they did not play a part worthy of mention in this report.

Values.

The values involved ran into many millions, but owing to the nature of the business were not readily ascertainable. At the Southern Fertilizer and Chemical Company approximate insurance values were, buildings and machinery, $385,000; stocks, $840,000.

As far as can be understood the only insurance carried at the railroad terminals was on cotton for owners' account, and this loss, at 28 cents per pound, should be in the neighborhood of $725,000.

Fire Protection.

This consisted of two 1,500-gallon steam pumps, one 1,000-gallon electric pump taking suction from Savannah river, and a 100,000-gallon tank, elevated 110 feet above grade. The mains were 16-inch, 12-inch, 10-inch, 8-inch and 6-inch, partially gridironed and supplying about ninety 2-way frost-proof 2½-inch hydrants and inside standpipes. All hydrants were equipped with hose houses and cotton rubber-lined hose. Buildings were equipped with standpipes and hose and full supply of casks and pails. There was a private fire brigade at Seaboard Terminals, but no fire apparatus.

Alarm Service.

The terminals were thoroughly equipped with American District Telegraph fire alarm system and the alarm was handled promptly through the central office in Savannah. The Savannah fire department was also notified, though the fire was outside of its jurisdiction. The chief went to the island with 39 men, all fire fighters, though not all were at the time members of the department. No apparatus was taken across the river on account, it is claimed, of the tide being low and the danger of getting stuck on a mud bank.

Remarks.

The failure to control this fire before such heavy damage was done was due primarily to the high wind, the great quantity of frame construction and the highly inflammable character of the materials stored and handled. The fire protection was inferior, but even with this the fire would probably have been confined to the fertilizer and chemical plant had the wind been moderate. The U. S. Weather Bureau records during

the time of the fire show wind velocity for Savannah as follows: 2 to 3 p. m., 33 miles per hour; 3 to 4 p. m., 35 miles per hour; 4 to 5 p. m., 32 miles per hour; 5 to 6 p. m., 26 miles per hour; 6 to 7 p. m., 20 miles per hour. The maximum velocity reached was 44 miles per hour, the figures given between hours being average velocity. Between 8 and 9 o'clock the direction of the wind changed from due east to northeast. The temperature at 2 p. m. was 70 degrees.

The large cotton warehouses were split up with 17-inch pilastered reinforced concrete walls, which suffered little damage and which, under ordinary circumstances, might have been expected to be of real value, but in this case were of none whatever, as the flying sparks and embers readily found their way through the open sides. The cotton loss in these warehouses was total. The tin-clad fire doors were sub-standard and broke down under the test, but the fire was already on both sides of them and their failure was of no importance.

The value of the large number of casks and pails at this fire is well worthy of note. Over 220 incipient fires were extinguished with these in an undestroyed nitrate storage shed, while a large number of fires in bales in cotton sheds and on platforms were similarly cared for. There is little reason to doubt that but for these casks and pails the loss would have been much greater.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending April 1, 1919, are given, and these are compared with the results of the total twenty-two year record ending at that time.

Although the number of fire reports available for tabulation this year exceeds last year's figure by 44, the whole of the increase goes to to the class of fires which did not gain sufficient headway to open sprinklers. The number of these fires rose from 325 to 376, while the fires in which sprinklers operated decreased from 1302 to 1295.

The abnormal conditions of the winter of 1917-1918 are to some extent reflected in this year's summary of sprinkler failures, as several cases of failure due to freezing or to water being shut off during "heatless" periods were reported too late for tabulation last year.

Possibly the unfavorable record of watchman efficiency in plants maintaining no other alarm is due to the demand for labor during the war. Undoubtedly the able-bodied watchman was confronted with many inducements to engage in other lines of work. It is also noticeable that the number of sprinkler alarm failures was above the average, indicating that this type of alarm service also suffered somewhat under the prevailing rush conditions.

Apart from this feature, the record confirms the impression gained from the tabulations of the past few years that standards of housekeeping are steadily improving. The proportion of fires incidental to the processes of industry and discovered immediately by employees is on the increase, and the occurrence of so many instances of extinguishment before sprinklers operated provides additional reason for satisfaction.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1918-1919. No. of Fires.	Per Cent.	1897-1919, incl. No. of Fires.	Per Cent.
Water shut off sprinklers	19	32.8	260	27.3
Generally defective equipment	6	10.3		
Unsprinklered portions	3	5.2	216	22.7
Defective heads	3	5.2		
Defective water supply or supplies	3	5.2	88	9.2
Sprinkler system crippled due to freezing	9	15.5	34	3.6
Slow operation of dry system or defective valve	1	1.7	20	2.1
Slow or defective operation of high test heads	..	..	17	1.8
Faulty building construction, concealed spaces, vertical openings, etc	4	6.9	43	4.5
Obstruction to distribution	5	8.6	59	6.2
Hazard of occupancy too severe for average sprinkler equipment	2	3.5	46	4.8
Explosion crippled sprinkler system	1	1.7	38	4.0
Exposure or conflagration	..	..	63	6.5
Miscellaneous	1	1.7	36	3.8
Plugged heads	..	..		
Not classified	1	1.7	33	3.5
Total	58		953	

Special Classification of Fires in Which Failure was Due to Water Being Shut off Sprinklers.

	1918-1919. No. of Fires.	1897-1919. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	5	102
Water shut off before fire was out or fire re-kindled	1	41
Water shut off due to accidents or repairs	4	42
Water shut off to prevent freezing	8	50
Water shut off, probably incendiary	..	3
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	1	9
Water shut off, defective gate valve	..	2
Total	19	260

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following ten tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 1671, which includes 376 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in the summary.

Table No. 1.

Time of Day.

	No. of Fires. 1918-1919.	No. of Fires. 1897-1919, incl.	Per Cent. of No. with Data Given. 1918-1919.	1897-1919, incl.
6 a. m. to 6 p. m.....	720	11050	56.6	57.6
6 p. m. to 6 a. m.....	553	8132	43.4	42.4
Total with data given....	1273	19182		
No data	22	386		
Total.....	1295	19568		

Table No. 2.

How Discovered.

	No. of Fires. 1918-1919.	No. of Fires. 1897-1919, incl.	Per Cent. of No. with Data Given 1918-1919.	1897-1919, incl.
Employee	789	11372	61.6	59.6
Watchman	185	2881	14.4	15.1
Sprinkler Alarm	197	2970	15.4	15.5
Outsider	50	968	3.9	5.1
Thermostats	24	646	1.9	3.4
Automatic Pump.....	..	11	..	.06
Supervisory System	36	237	2.8	1.24
Total with data given....	1281	19085		
No data	14	483		
Total.....	1295	19568		

Table No. 3.

Efficiency of Alarm Service 1918-1919.

NOTE.—This table does not include fires where alarm service does or does not operate promptly if fire is at once discovered by employees, the alarm service having no bearing on such fires one way or the other.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	106	87.6	15	12.4	121
Sprinkler Alarm alone.....	117	93.6	8	6.4	125
Thermostats alone	2	100.0	..	..	2
Supervisory System alone...	8	100.0	..	..	8

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	66	55*	103	18	..	..	..	..	121
Watchman and Thermostats	..	..	..	..	..	..	..	..	..
Sprinkler Alarm and Thermostats	..	..	19	2	19	2	..	..	21
Watchman, Sprinkler Alarm and Thermostats	2	6*	7	1	6	2	..	..	8
Sprinkler Alarm and Supervisory	..	..	32	3	..	..	34	1	35
Watchman and Supervisory	1	2*	..	..	..	..	3	..	3
Watchman, Sprinkler Alarm and Supervisory	6	15*	17	4	..	..	18	3	21
Sprinkler Alarm, Thermostats and Supervisory	..	..	2	..	2	..	2	..	2

* These include fires where sprinkler alarm or thermostat notified watchman.

Efficiency of Alarm Service, 1897-1919, Inclusive.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	1665	89.6	194	10.4	1859
Sprinkler Alarm alone.....	1851	93.8	123	6.2	1974
Thermostats alone	184	79.3	48	20.7	232

	Watchman.		Sprinkler. Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	1197	817*	1779	235	..	..	..	..	2014
Watchman and Thermostats	19	8*	..	..	25	2	..	..	27
Sprinkler Alarm and Thermostats	..	..	490	40	408	122	..	..	530
Watchman, Sprinkler Alarm and Thermostats	41	71*	104	8	84	28	..	..	112
Sprinkler Alarm and Supervisory	..	..	248	10	..	..	253	5	258
Watchman and Supervisory	6	9*	..	..	..	..	15	..	15
Watchman, Sprinkler Alarm and Supervisory	67	111*	170	8	..	..	172	6	178
Sprinkler Alarm, Thermostats and Supervisory	..	..	38	1	32	7	39	..	39

* These include fires where sprinkler alarm or thermostat notified the watchman.

Table No. 4.
Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1918-1919.	No. of Fires. 1897-1919, incl.	Per Cent. of No. with Data Given. 1918-1919.	Per Cent. of No. with Data Given. 1897-1919, incl.
1	413	6647	33.0	31.9
2	225	3439	18.0	16.5
3	125	2114	10.0	10.1
4	94	1530	7.5	7.3
5	44	967	3.5	4.6
6	43	831	3.4	4.0
7	45	542	3.6	2.6
8	21	519	1.7	2.5
9	19	356	1.5	1.7
10	21	317	1.7	1.5
11	11	264	.9	1.3
12	18	302	1.4	1.5
13	9	174	.7	.8
14	10	193	.8	.9
15	6	157	.5	.8
16 to 20	33	553	2.6	2.7
21 to 25	17	364	1.4	1.7
26 to 30	19	255	1.5	1.2
31 to 35	14	159	1.1	.8
36 to 40	13	140	1.0	.7
41 to 50	10	184	.8	.9
51 to 75	22	259	1.8	1.2
76 to 100	2	117	.2	.6
Over 100	17	458	1.4	2.2
Total with data given	1251	20841		
Water shut off sprinklers	19	226		
No data	25	325		
Total	1295	21392		

Table No. 5.
Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires. 1897-1919, incl.	Per Cent. of No. with Data Given. 1897-1919, incl.
1	6647	31.9
2 or less	10086	48.4
3 or less	12200	58.5
4 or less	13730	65.8
5 or less	14697	70.4
6 or less	15528	74.4
7 or less	16070	77.0
8 or less	16589	79.5
9 or less	16845	81.2
10 or less	17162	82.7
11 or less	17426	84.0

No. of Sprinklers Operating.	No. of Fires. 1897-1919, incl.	Per Cent. of No. with Data Given. 1897-1919, incl.
12 or less	17728	85.5
13 or less	17902	86.3
14 or less	18095	87.2
15 or less	18252	88.0
20 or less	18805	90.7
25 or less	19169	92.4
30 or less	19424	93.6
35 or less	19583	94.4
40 or less	19723	95.1
50 or less	19907	96.0
75 or less	20166	97.2
100 or less	20283	97.8
Over 100	458	2.2
Total with data given	20841	
Water shut off sprinklers	226	
No data	325	
Total	21392	

Table No. 6.

Sprinklers Opened on Wet or Dry Systems.

	No. of Fires 1918-1919.	No. of Fires 1897-1919, incl.	Per Cent. of No. with Data Given. 1918-1919.	Per Cent. of No. with Data Given. 1897-1919, incl.
Wet System	1095	15425	87.2	81.2
Dry System	161	3582	12.8	18.8
Total with data given	1256	19007		
Water shut off system	19	226		
No data	20	335		
	1295	19568		

Table No. 7.

Primary Water Supplies to Sprinklers Opened.

	No. of Fires. 1918-1919.	No. of Fires 1897-1919, incl.	Per Cent. of No. with Data Given. 1918-1919.	Per Cent. of No. with Data Given. 1897-1919, incl.
Waterworks	697	9855	56.9	52.1
Gravity Tank	272	5026	22.2	26.5
Pressure Tank	201	3007	16.4	15.9
Automatic Steam Pump	53	1022	4.3	5.39
Automatic Electric Pump	2	19	.2	.10
Steamer Connection	..	3	..	.01
Total with data given	1225	18932		
Water shut off system	19	226		
No data	51	420		
	1295	19578		

Table No. 8.

Effect of Sprinklers.

	No. of Fires. 1918-1919.	No. of Fires. 1897-1919, incl.	Per Cent. of Whole. 1918-1919.	Per Cent. of Whole. 1897-1919, incl.
Practically or entirely extinguished	879	13982	67.88	65.36
Held fire in check	358	6457	27.64	30.18
	1237	20439	95.52	95.54
Unsatisfactory	58	953	4.48	4.46
Total	1295	21392		

Table No. 9

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	47	59.5	28	35.4	75	94.9	4	5.1	79
Alcohol (Wood) Plant	..	....	1	100.0	1	100.0	..	..	1
Automobile and Bicycle Factories	71	60.2	41	34.7	112	94.9	6	5.1	118
Awning Factories	5	100.0	..	....	5	100.0	..	..	5
Bag Factories	6	66.7	3	33.3	9	100.0	..	..	9
Bakeries	40	66.7	18	30.0	58	96.7	2	3.3	60
Basket Factories	7	87.5	1	12.5	8	100.0	..	..	8
Bolt, Nut and Screw Works	16	72.7	6	27.3	22	100.0	..	..	22
Boot and Shoe Shops	417	73.8	127	22.5	544	96.3	21	3.7	565
Bottling Works	4	100.0	..	....	4	100.0	..	..	4
Braiding Mills	8	88.9	1	11.1	9	100.0	..	..	9
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	8	61.5	3	23.1	11	84.6	2	15.4	13
Brush Factories	15	78.9	4	21.1	19	100.0	..	..	19
Button Manufactories	26	83.9	4	12.9	30	96.8	1	3.2	31
Candle Factories	4	44.4	5	55.6	9	100.0	..	..	9
Candy Factories	67	72.0	25	26.9	92	98.9	1	1.1	93
Canning Works	8	66.7	3	25.0	11	91.7	1	8.3	12
Car Houses	23	47.9	19	39.6	42	87.5	6	12.5	48
Car Works	58	65.2	28	31.4	86	96.6	3	3.4	89
Carpet Mills	134	60.4	79	35.6	213	96.0	9	4.0	222
Carriage Factories	89	66.4	38	28.4	127	94.8	7	5.2	134
Celluloid (Pyroxylin Plastic)	100	69.9	27	18.9	127	88.8	16	11.2	143
Cement and Plaster Works	2	66.7	..	....	2	66.7	1	33.3	3
Cereal Mills	29	69.1	8	19.0	37	88.1	5	11.9	42
Chemical and White Lead	55	57.3	34	35.4	89	92.7	7	7.3	96
Clothing Factories	511	81.1	112	17.8	623	98.9	7	1.1	630
Coffee and Spice Mills	36	70.6	14	27.4	50	98.0	1	2.0	51
Coffin Factories	36	78.3	9	19.5	45	97.8	1	2.2	46
Cold Storage Plants	4	50.0	4	50.0	8	100.0	..	..	8
Cooperage Plants	42	54.5	26	33.8	68	88.3	9	11.7	77
Cordage Works	188	66.4	85	30.1	273	96.5	10	3.5	283
Cork Factories	8	47.1	7	41.2	15	88.3	2	11.7	17
Corset Factories	6	60.0	3	30.0	9	90.0	1	10.0	10
Cotton Ginnery	10	66.7	5	33.3	15	100.0	..	..	15
Cotton Mills	3295	62.1	1949	36.8	5244	98.9	60	1.1	5304
Cotton Warehouses	108	46.4	103	44.2	211	90.6	22	9.4	233
Cotton Seed Oil Mills	36	52.9	21	30.9	57	83.8	11	16.2	68
Cutlery and Tools	11	57.9	7	36.8	18	94.7	1	5.3	19

Table No. 9 — Continued.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Department Stores	302	79.7	66	17.4	368	97.1	11	2.9	379
Distilleries	8	80.0	2	20.0	10	100.0	..	..	10
Drug Houses	122	79.7	27	17.7	149	97.4	4	2.6	153
Dry Cleaning Establishments	5	83.3	1	16.7	6	100.0	..	..	6
Dyeing, Bleaching and Finishing	111	50.9	97	44.5	208	95.4	10	4.6	218
Electrical Appliances	106	75.2	31	22.0	137	97.2	4	2.8	141
Electric Light and Power Plants	2	33.4	2	33.3	4	66.7	2	33.3	6
Elevators, Grain	21	36.8	21	36.8	42	73.6	15	26.4	57
Excelsior Factories	22	78.6	5	17.8	27	96.4	1	3.6	28
Fertilizer Plants	16	61.5	8	30.8	24	92.3	2	7.7	26
Flax and Linen Mills	19	48.7	20	51.3	39	100.0	..	..	39
Flour and Grist Mills	45	57.7	26	33.3	71	91.0	7	9.0	78
Forge and Smithy	11	73.3	4	26.7	15	100.0	..	..	15
Foundries	112	56.3	78	39.2	190	95.5	9	4.5	199
Furniture Factories	390	64.6	163	27.0	553	91.6	51	8.4	604
Garages	62	65.2	30	31.6	92	96.8	3	3.2	95
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	100.0	..	....	2	100.0	..	..	2
Glass Works	38	55.9	24	35.3	62	91.2	6	8.8	68
Glove Factories	8	88.9	1	11.1	9	100.0	..	..	9
Glue Factories	4	40.0	4	40.0	8	80.0	2	20.0	10
Groceries	50	82.0	7	11.5	57	93.5	4	6.5	61
Harness and Fancy Leather	57	79.2	15	20.8	72	100.0	..	..	72
Hat, Fur	45	69.2	15	23.1	60	92.3	5	7.7	65
Hat, Straw	15	62.5	9	37.5	24	100.0	..	..	24
Hatters' Fur Mfg	9	56.2	6	37.5	15	93.7	1	6.3	16
Ice Plants	2	100.0	..	....	2	100.0	..	..	2
Incandescent Lamp Factories	12	60.0	8	40.0	20	100.0	..	..	20
Insulated Wire Factories	24	68.6	11	31.4	35	100.0	..	..	35
Jewelry Shops	100	88.5	9	8.0	109	96.5	4	3.5	113
Junk Shops	8	80.0	1	10.0	9	90.0	1	10.0	10
Knitting Mills, Cop Yarn	39	60.9	19	29.7	58	90.6	6	9.4	64
Knitting Mills, Full Process	410	64.4	204	32.0	614	96.4	23	3.6	637
Laundries	32	66.7	14	29.2	46	95.9	2	4.1	48
Lead Pencil Factories	11	64.7	6	35.3	17	100.0	..	..	17
Linseed Oil Works	13	56.5	9	39.1	22	95.6	1	4.4	23
Machine Shops	266	66.5	113	28.3	379	94.8	21	5.2	400
Match Factories	44	73.3	12	20.0	56	93.3	4	6.7	60
Mattress Factories	240	73.6	81	24.9	321	98.5	5	1.5	326
Mercantile	571	79.2	133	18.4	704	97.6	17	2.4	721
Metal Reduction Works	3	75.0	1	25.0	4	100.0	..	..	4
Metal Workers	527	64.9	248	30.5	775	95.4	37	4.6	812
Miscellaneous	300	69.3	113	26.1	413	95.4	20	4.6	433
Morocco Leather Shops	13	46.4	11	39.3	24	85.7	4	14.3	28
Motion Pictures	29	76.3	8	21.1	37	97.4	1	2.6	38
Munition Factories	14	42.4	13	39.4	27	81.8	6	18.2	33
Musical Instrument Factories	90	69.2	35	26.9	125	96.1	5	3.9	130
Oil Clothing Factories	10	71.4	4	28.6	14	100.0	..	..	14
Oilcloth and Linoleum Works	23	27.3	43	51.2	66	78.5	18	21.5	84
Oil Refineries	4	40.0	6	60.0	10	100.0	..	..	10
Packing House and Slaughter	70	66.0	31	29.3	101	95.3	5	4.7	106
Paint and Color Works	116	69.9	45	27.1	161	97.0	5	3.0	166
Paper Box and Papeterie	96	74.4	32	24.8	128	99.2	1	.8	129
Paper Mills	268	50.9	206	39.2	474	90.1	52	9.9	526
Patent Leather Works	7	36.9	10	52.6	17	89.5	2	10.5	19
Picture Frame Factories	31	63.3	13	26.5	44	89.8	5	10.2	49
Plumbers' Supplies	13	81.3	3	18.7	16	100.0	..	..	16
Potteries	37	64.9	17	29.8	54	94.7	3	5.3	57

Table No. 9 — Concluded.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Printing and Lithographing	386	80.5	79	16.5	465	97.0	15	3.0	480
Pulp, Miscellaneous	7	26.9	14	53.9	21	80.8	5	19.2	26
Pulp, Soda	1	20.0	1	20.0	2	40.0	3	60.0	5
Pulp, Sulphite	16	39.0	18	43.9	34	82.9	7	17.1	41
Restaurants	15	83.3	2	11.1	17	94.4	1	5.6	18
Rice Mills	..	....	1	100.0	1	100.0	..	..	1
Rolling, Wire and Tube Works	20	52.6	16	42.1	36	94.7	2	5.3	38
Roofing Works	14	38.9	21	58.3	35	97.2	1	2.8	36
Rubber Cloth Factories	18	66.7	9	33.3	27	100.0	..	..	27
Rubber Reclaiming Works	3	27.3	7	63.6	10	90.9	1	9.1	11
Rubber Works	99	52.9	79	42.3	178	95.2	9	4.8	187
Saw and Planing Mills	62	41.9	50	33.8	112	75.7	36	24.3	148
Shirt Factories	32	82.1	7	17.9	39	100.0	..	..	39
Shoddy Mills	160	65.3	69	28.2	229	93.5	16	6.5	245
Silk Mills	36	67.9	13	24.5	49	92.4	4	7.6	53
Skin Mills	2	66.7	1	33.3	3	100.0	..	..	3
Soap Manufacturing	21	80.8	4	15.4	25	96.2	1	3.8	26
Stamping and Sheet Metal Works	36	61.0	18	30.5	54	91.5	5	8.5	59
Starch and Glucose Mills	10	50.0	4	20.0	14	70.0	6	30.0	20
Sticky Fly Paper Factories	3	75.0	1	25.0	4	100.0	..	..	4
Sugar Refineries	15	65.2	7	30.4	22	95.6	1	4.4	23
Tanneries	33	50.0	26	39.4	59	89.4	7	10.6	66
Tenant Manufacturing	418	71.0	140	23.8	558	94.8	31	5.2	589
Theatres	35	79.5	8	18.2	43	97.7	1	2.3	44
Tobacco Factories	38	64.4	18	30.5	56	94.9	3	5.1	59
Trunk Factories	9	75.0	3	25.0	12	100.0	..	..	12
Varnish Works	6	54.6	3	27.2	9	81.8	2	18.2	11
Wall Paper Factories	11	68.8	2	12.5	13	81.3	3	18.7	16
Warehouses	210	70.2	72	24.1	282	94.3	17	5.7	299
Waste and Batting Mills	202	63.7	106	33.4	308	97.1	9	2.9	317
Waste Paper and Rag Shops	39	61.9	22	34.9	61	96.8	2	3.2	63
Weaving Mills	92	63.9	48	33.3	140	97.2	4	2.8	144
Whip Factories	4	66.7	2	33.3	6	100.0	..	..	6
Window Shade Factories	9	81.8	..	....	9	81.8	2	18.2	11
Woodworkers, Class A*	106	52.8	69	34.3	175	87.1	26	12.9	201
Woodworkers, Class B*	116	50.6	89	38.9	205	89.5	24	10.5	229
Woodworkers, Class C*	97	59.1	57	34.8	154	93.9	10	6.1	164
Woodworkers, Class D*	70	58.3	35	29.2	105	87.5	15	12.5	120
Woodworkers, Class E*	95	62.9	46	30.5	141	93.4	10	6.6	151
Woodworkers, Class F*	28	62.2	13	28.9	41	91.1	4	8.9	45
Woolen Mills	802	71.4	268	23.9	1070	95.3	53	4.7	1123
Wool Storehouses	23	67.6	9	26.5	32	94.1	2	5.9	34
Worsted Mills	40	49.4	29	35.8	69	85.2	12	14.8	81
Total Sprinkler Fires	13,982		6,457		20,439		953		21,392

*The Woodworkers are classed as follows:

Class A. Interior woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant woodworkers (also woodworkers where there is a lack of detailed information as to class).

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc.. last and wood heel factories).

Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc).

Table No. 10

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Agricultural Implements	3	..	..	..	..	..	..	..	1	..	..	..	..	4
Automobile and Bicycle	2	1	..	..	..	..	..	2	..	..	1	..	..	6
Bakeries	..	1	..	..	..	..	..	..	..	..	..	1	..	2
Boot and Shoe Shops	7	2	2	..	..	1	..	1	..	2	5	..	1	21
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Candy Factories	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Canning Works	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Car Houses	1	2	1	..	1	..	..	1	..	..	..	..	..	6
Car Works	1	1	..	..	..	..	..	1	..	..	..	..	..	3
Carpet Mills	4	1	3	..	..	..	..	1	..	..	..	..	..	9
Carriage Factories	..	1	2	..	1	..	..	1	..	..	2	..	..	7
Celluloid (Pyroxylin)	..	..	2	1	1	..	1	..	7	3	1	..	..	16
Cement and Plaster Works	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills	..	2	1	..	..	..	..	..	..	2	..	..	..	5
Chemical and White Lead	1	4	..	..	..	..	..	..	..	2	..	..	..	7
Clothing Factories	3	..	1	..	..	..	2	1	..	..	..	..	..	7
Coffee and Spice Mills	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Coffin Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Cooperage Plants	1	3	..	..	..	1	..	3	..	..	1	..	..	9
Cordage Works	2	3	1	1	..	..	..	2	..	..	..	..	1	10
Cork Factories	1	..	..	..	..	..	..	..	..	1	..	..	..	12
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	11
Cotton Mills	22	15	6	2	..	1	4	1	1	..	..	4	4	60
Cotton Warehouses	12	1	2	..	..	..	1	4	1	..	..	1	..	22
Cotton Seed Oil Mills	2	4	2	..	..	..	..	..	..	..	..	2	1	11
Cutlery and Hardware	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Department Stores	4	3	..	..	..	..	..	1	..	..	2	..	1	11
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	1	..	4
Dyeing, Bleaching and Finishing	3	2	1	..	..	1	..	1	..	..	1	..	1	10
Electrical Appliances	1	..	2	..	..	..	..	..	..	..	..	..	1	4
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain	..	3	3	..	1	..	2	1	1	1	2	..	1	15
Excelsior Factories	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Fertilizer Plants	1	..	..	..	1	..	..	..	..	..	..	..	..	2
Flour and Grist Mills	..	1	1	..	..	..	1	..	..	2	2	..	..	7
Foundries	6	1	1	..	..	..	..	..	..	1	..	..	..	9
Furniture Factories	15	12	2	3	..	..	2	9	6	..	2	..	..	51
Garages	1	..	..	..	..	..	..	2	..	..	..	..	..	3
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	1	1	1	..	..	..	..	1	..	..	..	..	2	6
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2

Table No. 10 — Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Groceries	3	..	..	..	1	..	..	..	..	..	..	..	..	4
Hat, Fur	1	2	1	..	1	..	..	..	..	..	..	..	..	5
Hatters' Fur Mfg	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	1	..	..	..	..	..	..	..	..	..	4
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	..	1	3	..	..	..	..	1	..	1	..	..	..	6
Knitting, Full Process	6	9	5	1	1	..	..	..	..	1	..	..	..	23
Laundries	1	..	..	..	..	..	..	1	..	..	..	..	..	2
Linseed Oil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Machine Shops	12	3	1	1	..	1	..	1	..	1	..	1	..	21
Match Factories	2	..	..	..	..	..	..	..	1	..	..	1	..	4
Mattress Factories	2	1	..	1	..	..	..	1	..	..	..	..	..	5
Mercantile	6	2	..	2	..	..	2	..	..	..	4	..	1	17
Metal Workers	13	13	2	..	..	..	1	..	1	2	2	1	2	37
Miscellaneous	2	4	2	1	1	..	3	..	3	1	2	1	..	20
Morocco Leather Shops	1	2	..	..	..	..	1	..	..	..	..	..	..	4
Motion Pictures	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Munitions Factories	2	..	..	..	..	..	..	..	3	..	..	1	..	6
Musical Instrument Factories	..	3	..	..	..	..	1	..	..	..	1	..	..	5
Oilcloth and Linoleum Works	..	4	..	..	..	..	1	2	11	..	..	..	..	18
Packing House and Slaughter	1	2	1	..	1	..	..	..	..	..	..	..	..	5
Paint and Color Works	1	2	1	..	..	..	1	..	..	..	..	..	..	5
Paper Box and Papeterie	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Paper Mills	10	17	4	3	..	2	2	..	2	1	2	5	4	52
Patent Leather Works	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Picture Frame Factories	1	2	..	1	..	..	..	1	..	..	..	..	..	5
Potteries	1	..	..	1	..	..	..	..	..	1	..	..	..	3
Printing and Lithographing	5	4	1	..	..	..	..	1	..	..	3	1	..	15
Pulp, Miscellaneous	1	1	2	..	..	..	..	..	..	1	..	..	..	5
Pulp, Soda	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Pulp, Sulphite	3	1	..	..	1	1	..	..	..	..	..	..	1	7
Restaurants	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rolling, Wire and Tube Works	..	..	..	..	..	..	1	..	..	..	..	..	1	2
Roofing Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Rubber Reclaiming Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rubber Works	5	..	..	1	..	..	..	..	2	1	..	..	..	9
Saw and Planing Mills	8	7	1	..	3	1	6	2	1	..	4	1	2	36
Shoddy Mills	5	2	5	..	..	3	..	..	..	..	..	1	..	16
Silk Mills	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	..	2	1	..	1	..	..	..	..	..	1	..	..	5
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	5	..	..	..	6

Table No. 10 — Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Sugar Refineries	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Tanneries	1	1	..	3	..	..	..	..	..	..	1	..	1	7
Tenant Manufacturing	12	5	2	2	1	..	1	1	..	..	6	..	1	31
Theatres	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Tobacco Factories	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Varnish Works	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Wall Paper Factories	..	..	1	..	..	..	..	1	..	..	1	..	..	3
Warehouses	9	2	1	..	1	..	..	3	..	..	..	..	1	17
Waste and Batting Mills	1	3	1	1	..	1	..	1	..	..	..	1	..	9
Waste Paper and Rag Shops	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Weaving Mills	1	1	1	1	..	..	..	..	..	..	..	..	..	4
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*	5	8	..	..	..	..	..	5	..	2	3	3	..	26
Woodworkers, Class B*	5	8	2	1	..	1	1	1	..	2	2	1	..	24
Woodworkers, Class C*	3	4	1	..	..	..	..	2	..	..	..	..	..	10
Woodworkers, Class D*	1	6	..	1	..	..	..	..	..	1	3	3	..	15
Woodworkers, Class E*	3	2	..	..	2	1	2	..	..	..	..	..	..	10
Woodworkers, Class F*	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills	10	15	10	1	..	2	3	..	1	..	3	4	4	53
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	2	3	2	1	..	..	..	..	..	..	..	2	2	12
Total Unsatisfactory Fires	260	216	88	34	20	17	43	59	46	38	63	36	33	953

* See detailed classification of woodworkers as given in note under Table No. 9.

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